THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 60 AUGUST, 1936 NO. 4

RINDERPEST STUDIES

By MANUEL M. ROBLES
Of the Bureau of Animal Industry, Manila

FIFTEEN TEXT FIGURES

I. ANTIRINDERPEST IMMUNE AND HYPERIMMUNE SERA

Ruediger (1910) and Hall (1933, cited by Bennett, 1934) both failed to notice any difference in the "titre" or protective value of "non-reactor" and "reactor" immune sera. But Ward and Wood (1912) demonstrated that the latter is more highly protective, as animals injected with it developed an average of 9.7 days of diagnostic symptoms plus febrile period as against 12.1 days among those given the nonreactor serum. On the other hand, Carmichael (1928) claims that nonreactor sera are useless.

Opinions are likewise at variance as to what factors determine the titer of a reactor immune serum. Edwards (1925) and Carmichael (1928) agree that such titer varies in direct relationship to the severity of the original reaction. On the contrary, Bennett (1934) claims that immune serum from cattle that have undergone a partially controlled attack of rinderpest "is of extremely variable potency; the potency, moreover, appears not to bear a constant relation either to severity of the symptoms or to the intensity of any particular symptom." In fact Kearney (1925, cited by Bennett, 1934) observed by parallel tests that serum from a beast that had given the lesser preliminary reaction gave better results. Topacio (1922) on the other hand showed that a febrile reaction of 39.5° to 40° C. and above for three or four consecutive days can produce a

reactor serum that he found to be as potent as the hyperimmune sera manufactured in the Philippines, the Pasteur Institute of Nathrang, and the laboratories of Harbin.

With regard to the effect of hyperimmunization, Edwards (1925) believes that "subsequent to the initial treatment of the serum producers there occurs what appears to be a maximum diffusion of the virus throughout the body which results in the development of such a state of immunity on the part of the tissues that the injection afterwards of the amounts of virus that are contained in massive quantities of virulent ox blood set up no more than a local disturbance quite incapable of evoking a tissue response sufficient to drive up the antibody content of the blood beyond the maximum titre attained following the preliminary treatment." Daubney (1928) appears to hold the same view. The work of Bennett (1934), however, demonstrates that "beasts providing immune serum of low potency will provide hyperimmune serum of high value after immunization." Rabagliati (1925) likewise proved that serum produced after Todd's method of hyperimmunization was more potent than the ordinary reactor serum.

Some of the controversial aspects of the subject of "immune and hyperimmune serums" are thus indicated. So with a view of shedding more light on these aspects, the following experiments were undertaken.

MATERIALS AND METHODS

NONREACTOR IMMUNE SERA

(1) *NR-3409.*—This was obtained from Fuga bull 3409 (fig. 1), which was vaccinated with 10 cc of glycerine-formolized rinderpest vaccine September 24, 1934; inoculated with 1 cc of fresh virulent blood October 10; developed no reaction thereafter; and finally was bled for serum November 5, 26 days after virus inoculation.

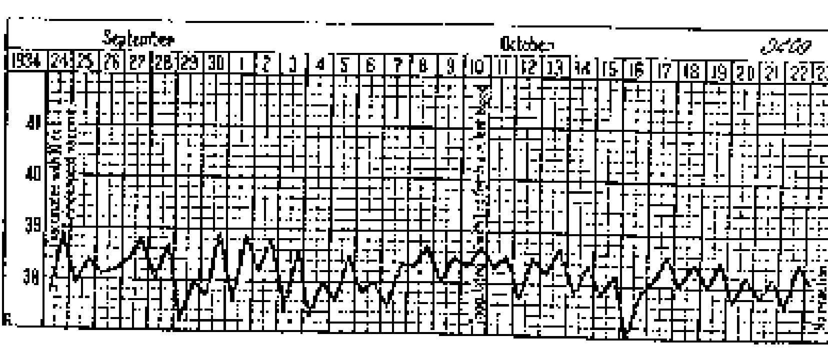

FIG. 1. Temperature chart of nonreactor serum producer 3409.

(2) *NR-3510.*—This was obtained from Fuga bull 3510, which was vaccinated with 0.5 g of dried rinderpest vaccine October 24, 1934; inoculated with 1 cc of fresh virulent blood November 7; developed no reaction thereafter; and finally was bled for serum November 29, 22 days after the virus inoculation.

(3) *NR-3680.*—This was obtained from Fuga bull 3680, which was vaccinated with 5 g of dried rinderpest vaccine October 23, 1935; inoculated with 0.5 cc of fresh virulent blood November 26; developed no reaction thereafter; and finally was bled for serum December 9, 14 days after virus inoculation.

(4) *NR-3684.*—This was obtained from Fuga bull 3684, which was vaccinated, reacted, and was bled in the same manner as NR-3680.

MILD REACTOR IMMUNE SERA

(1) *TR-3585.*—This was obtained from Fuga bull 3585 (fig. 2), which was simultaneously injected with 70 cc of antirinderpest immune serum and 2 cc of fresh virulent blood December 5, 1934; developed a low thermal reaction (below 40° C.) for 2 days; and finally was bled for serum December 27, 22 days after virus inoculation.

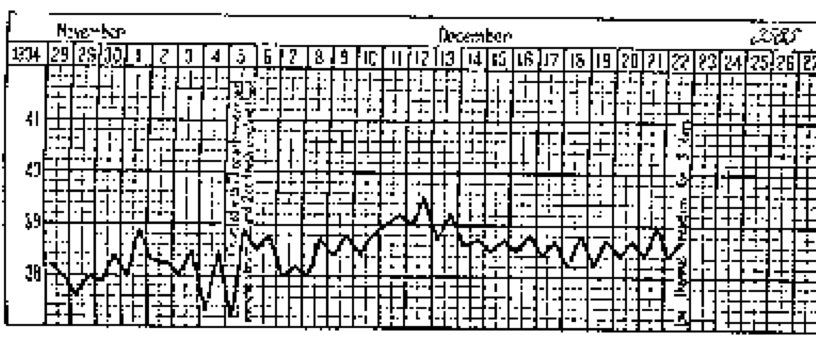

FIG. 2. Temperature chart of mild reactor serum producer 3585.

(2) *TR-3662.*—This was obtained from Tayabas bull 3662 (fig. 3), which was inoculated with 2 cc of fresh virulent blood July 30, 1935; developed a high thermal reaction (40° C. or over) for 8 days; and finally was bled for serum August 20, 21 days after virus inoculation.

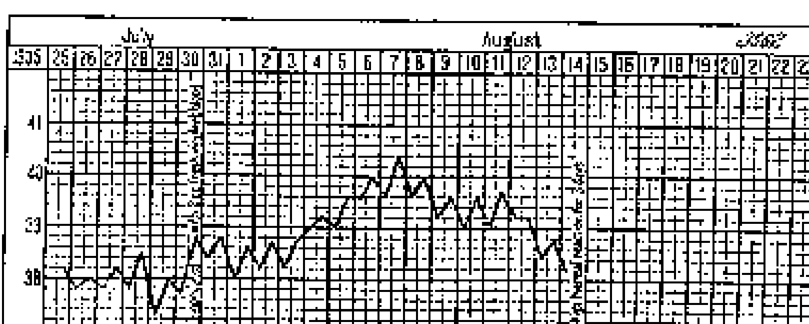

FIG. 3. Temperature chart of mild reactor serum producer 3662.

(3) *TR-3259.*—This was obtained from Fuga bull 3259 (fig. 4), which was vaccinated with 0.5 g of dried rinderpest vaccine September 10, 1934; inoculated with 1 cc of fresh virulent blood October 3; developed a high thermal reaction for 3 days; and finally was bled for serum November 5, 33 days after virus inoculation.

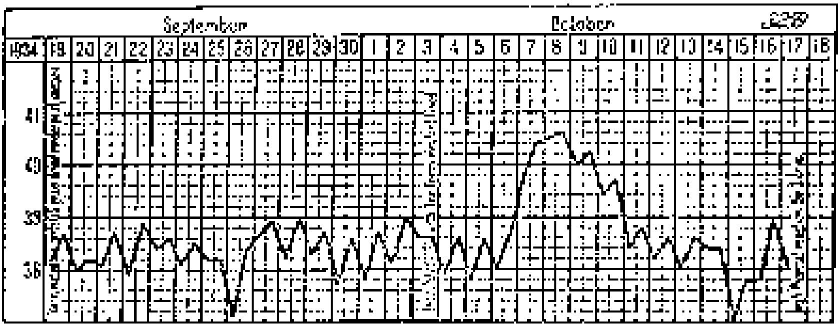

FIG. 4. Temperature chart of mild reactor serum producer 3259.

MARKED REACTOR IMMUNE SERA

(1) *TR-3566.*—This was obtained from Fuga bull 3566 (fig. 5), which was vaccinated with 0.5 g of dried rinderpest vaccine April 21, 1935; inoculated with 2 cc of fresh virulent blood May 7; developed a high thermal reaction for 4 days; and finally was bled for serum May 26, 19 days after virus inoculation.

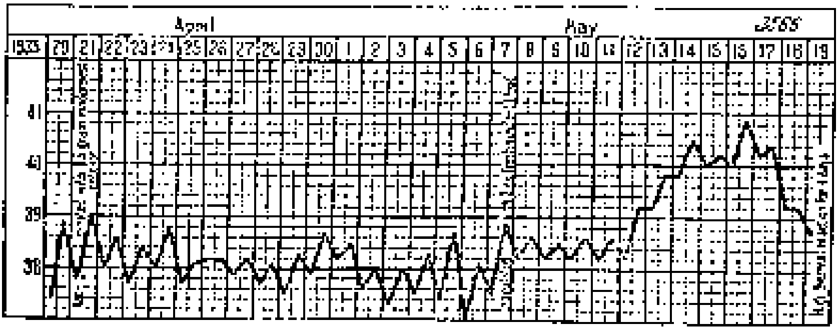

FIG. 5. Temperature chart of marked reactor serum producer 3566.

(2) *TR-3623.*—This was obtained from Fuga bull 3623, which was inoculated with 10 cc of fresh virulent blood August 7, 1934; developed a high thermal reaction for 5 days; and finally was bled for serum August 28, 21 days after virus inoculation.

(3) *TR-3660.*—This was obtained from Romblon bull 3660 (fig. 6), which was simultaneously injected with 19 cc of antirinderpest immune serum and 2 cc of fresh virulent blood July 30, 1935; developed a high thermal reaction for 6 days; and finally was bled for serum September 3, 35 days after virus inoculation.

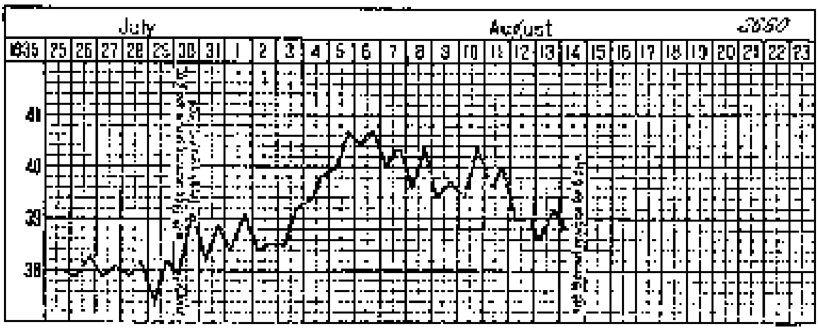

FIG. 6. Temperature chart of marked reactor serum producer 3560.

(4) *TR-3403.*—This was obtained from Fuga bull 3403, which was vaccinated with 10 cc of glycerine-formolized rinderpest vaccine September 27, 1934; inoculated with 1 cc of fresh virulent blood October 10; developed a high thermal reaction for 6 days; and finally was bled for serum November 1, 22 days after virus inoculation.

(5) *RR-3420.*—This was obtained from Fuga bull 3420, which was vaccinated with 10 cc of glycerine-formolized rinderpest vaccine September 27, 1934; inoculated with 1 cc of fresh virulent blood October 10; developed a severe rinderpest reaction (high thermal reaction for 5 days plus diarrhœa for 2 days); and finally was bled for serum November 5, 26 days after virus inoculation.

HYPERIMMUNE SERA

(1) *HI-3541 (from a marked reactor with a lapsed titer).*—This was obtained from Fuga bull 3541, which was simultaneously injected with 12 cc of antirinderpest immune serum and 2 cc of fresh virulent blood February 20, 1935; developed a high thermal reaction for 6 days; was injected intramuscularly with 1,500 cc (7 cc per kilo body weight) of fresh virulent blood June 3 (103 days after the preliminary virus inoculation) and a similar amount June 13 (fig. 7); and finally was bled for hyperimmune serum June 24, 11 days after the last massive virus injection.

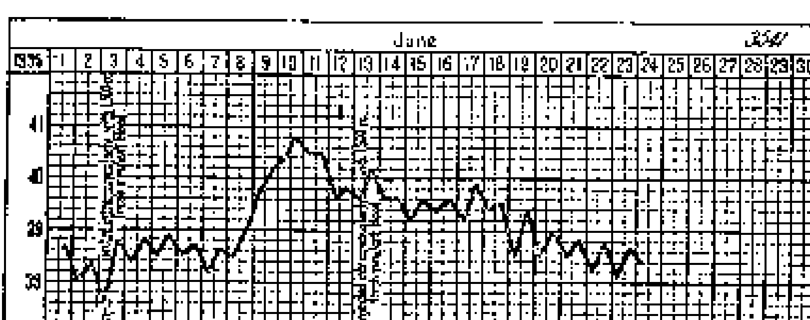

FIG. 7. Temperature chart of hyperimmune serum producer 3541 (formerly producer of marked reactor serum, TR-3541).

(2) *HI-3585 (from a mild reactor).*—This was obtained from Fuga bull 3585 (producer of mild reactor serum, TR-3585), which was injected intramuscularly with 3,000 cc (17 cc per kilo body weight) of fresh virulent blood December 29, 1934 (24 days after the preliminary virus inoculation), and a similar amount January 9 (fig. 8); and finally was bled for hyperimmune serum January 24, 14 days after the last massive virus injection.

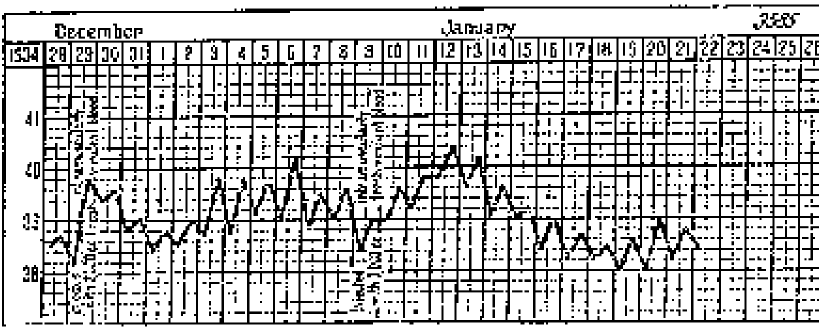

FIG. 8. Temperature chart of hyperimmune serum producer 3585 (formerly producer of mild reactor serum, TR-3585).

(3) *HI-3403 (from a marked reactor).*—This was obtained from Fuga bull 3403 (producer of marked reactor serum, TR-3403), which was injected intramuscularly with 4,000 cc (19 cc per kilo body weight) of virulent blood November 7, 1934 (28 days after the preliminary virus inoculation), and a similar amount November 14 (fig. 9); and finally was bled for hyperimmune serum December 10, 26 days after the last massive virus injection.

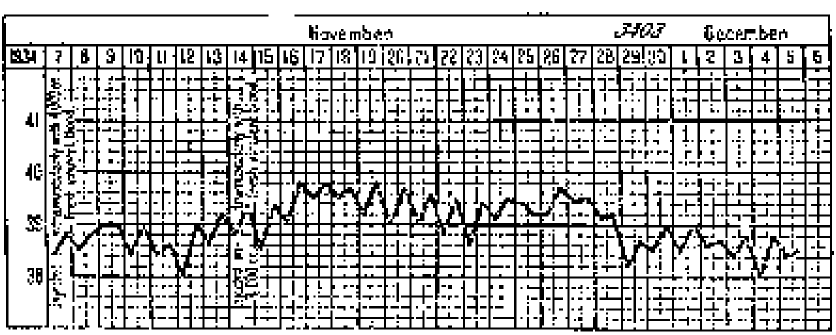

FIG. 9. Temperature chart of hyperimmune serum producer 3403 (formerly producer of marked reactor serum, TR-3403).

(4) *HI-3566 (from a marked reactor).*—This was obtained from Fuga bull 3566 (producer of marked reactor serum, TR-3566), which was injected intramuscularly with 1,500 cc (7 cc per kilo body weight) of fresh virulent blood June 3, 1935 (27 days after the preliminary virus inoculation), and a similar amount June 13 (fig. 10); and finally was bled for hyperimmune serum June 24, 11 days after the last massive virus injection.

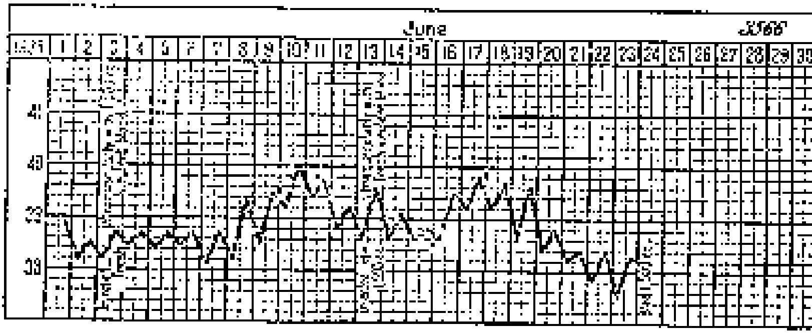

FIG. 10. Temperature chart of hyperimmune serum producer 3566 (formerly producer of blocked factor, TB-3566).

PREPARATION OF THE SERUM

Blood drawn from each serum producer was collected in 2-liter sterile Pyrex bleeding tubes which contained 10 cc of 95 per cent ethyl alcohol. It was then allowed to stand at room temperature for 24 hours, after which the serum was poured into appropriate containers and subsequently stored at 0° to 3° C. until used.

METHOD OF TESTING THE SERUM

Native cattle 2 to 4 years old and weighing from 175 to 286 kilos were used; and these animals, coming from Fuga, Romblon, and Zamboanga where rinderpest has not been known to exist for many years, are noted for their high susceptibility to rinderpest. The required dose of serum, which was based on the body weight, and 2 cc of fresh virulent blood were simultaneously inoculated into these animals. (Controls were likewise inoculated with the blood used in each test; all of them developed clinical or severe rinderpest reactions.)

Those animals that failed to show any response to the virus within a period of two weeks were declared to have had no reaction; those which had developed only a temperature response were either considered to have had a low (below 40° C.) or a high (40° C. or over) thermal reaction; those which had exhibited visible clinical symptoms of rinderpest, such as lacrimation, nasal discharges, and mouth ulceration, were said to have had a clinical rinderpest reaction; and those which had developed the above-mentioned clinical symptoms plus diarrhœa, were considered to have had a severe rinderpest reaction. The last two types of reaction were interpreted as negative results, for in both instances inadequacy of protective power was evident.

TESTS AND RESULTS

NONREACTOR IMMUNE SERA

As shown in Table 1, of the two test animals injected with 10 cc per 100 kilos body weight of nonreactor serum, none was adequately protected; but at 40 cc the serum showed a high degree of protective power. And in two other tests (experiments 5 and 6) an equivalent dosage of 100 cc of nonreactor serum was sufficient to prevent any reaction in the test animals.

TABLE 1.—*Tests on nonreactor immune sera and results.*

Experiment No.	Serum No.	Dosage per 100 kilos.	Actual dose.	Bull No.	Results after virus inoculation.
		cc.	*cc.*		
1	NR-3409	40	103	3523	High thermal reaction for 1 day.
2	NR-3409	10	22	3551	Clinical rinderpest reaction.
3	NR-3510	40	94	3503	High thermal reaction for 5 days.
4	NR-3510	10	21	3567	Severe rinderpest reaction.
5	NR-3580	100	200	3682	No reaction.
6	NR-3584	100	190	3689	Do.

REACTOR IMMUNE SERA

The results shown in Table 2 indicate that mild reactor sera, when given at 10 cc per 100 kilos body weight, were able to protect 1 of 5 test animals; while the marked reactor sera were able to protect in 6 of 7 tests. Likewise, at the equivalent dosage of 40 cc, the former protected 1 of 3 test animals. It would thus appear that the minimum protective dose of the mild reactor serum lies above 40 cc and that of the marked reactor serum is at 10 cc per 100 kilos body weight.

In actual practice, however, the use of such minimum dosage is attended with some risk, as very susceptible animals (see experiment 19) may not be adequately protected by it.

HYPERIMMUNE SERA

As seen in Table 3, all of the hyperimmune sera were protective at 10 cc per 100 kilos body weight; but at 5 cc 4 of 8 test animals developed clinical or severe rinderpest reactions. Hence, for practical purposes the amount of 10 cc per 100 kilos body weight may be considered as the minimum protective dose of the hyperimmune sera.

The beneficial effect of hyperimmunization on marked reactor sera, TR–3403 and TR–3566, was thus practically nil. However, in the case of the marked reactor serum, TR–3541, the

titer of which was allowed to lapse, and of the mild reactor serum, TR–3585, the increase in titer is clearly apparent.

TABLE 2.—*Tests on reactor immune sera and results.*

Experiment No.	Serum No.	Dosage per 100 kilos.	Actual dose.	Bull No.	Results after virus inoculation
		cc.	cc.		
7	TR-3585	40	120	3561	Clinical rinderpest reaction.
8	TR-3585	10	19	3698	High thermal reaction for 3 days.
9	TR-3585	10	22	3675	Severe rinderpest reaction.
10	TR-3662	40	70	3671	High thermal reaction for 2 days.
11	TR-3662	10	23	3654	Severe rinderpest reaction.
12	TR-3662	10	28	3653	Do.
13	TR-3269	40	70	3586	Do.
14	TR-3269	10	27	3569	Do.
15	TR-3666	10	19	3662	High thermal reaction for 5 days.
16	TR-3666	6	10	3693	High thermal reaction for 3 days.
17	TR-3666	6	10	3699	Do.
18	TR-3523	10	22	3706	High thermal reaction for 5 days.
19	TR-3623	10	19	3663	Severe rinderpest reaction.
20	TR-3660	10	18	3668	High thermal reaction for 5 days.
21	TR-3660	10	21	3653	High thermal reaction for 3 days.
22	TR-3403	40	93	3526	No reaction.
23	TR-3403	20	43	3524	High thermal reaction for 1 day.
24	TR-3403	20	36	3663	High thermal reaction for 4 days.
25	TR-3403	10	19	3571	High thermal reaction for 6 days.
26	RR-3420	40	70	3585	Low thermal reaction for 3 days.
27	RR-3420	10	20	3556	Low thermal reaction for 4 days.

TABLE 3.—*Tests on hyperimmune sera and results.*

Experiment No.	Serum No.	Dosage per 100 kilos	Actual dose.	Bull No.	Results after virus inoculation.
		cc.	cc.		
28	[a] HI-3541	10	19	3616	High thermal reaction for 5 days.
29	HI-3541	5	10	3647	Do.
30	HI-3541	5	13	3692	High thermal reaction for 6 days.
31	HI-3585	10	21	3572	Do.
32	HI-3585	5	10	3595	Clinical rinderpest reaction.
33	HI-3585	5	10	3549	Severe rinderpest reaction.
34	HI-3403	10	27	3456	No reaction.
35	HI-3403	10	21	3564	Low thermal reaction for 7 days.
36	HI-3403	5	12	3641	Clinical rinderpest reaction.
37	HI-3403	5	9	3574	Severe rinderpest reaction.
38	HI-3566	5	11	3707	High thermal reaction for 4 days.
39	HI-3566	5	12	3702	High thermal reaction for 5 days.

[a] This serum prior to hyperimmunization failed to protect bull 3639 at 40 cc and bull 3616 at 10 cc per 100 kilos body weight.

COMMENT

The data presented herein are far from being conclusive in some respects, but the indications are clear. So, if we regard

the few discrepant results as being largely due to marked differences in the susceptibility of the test animals used, the data will serve as a basis for a rational interpretation of some of the existing controversial opinions on the subject.

In the present study the tests were performed on individual samples of immune and hyperimmune sera. Besides, the thermal response was adopted as the guide in determining the severity of the original reaction of the serum producers. Consequently it was possible to correlate with certainty such reaction to the titer or protective value of the serum produced, which otherwise would not be possible to do if "pooled samples" were used.

The use of "pooled samples," as heretofore practiced by many investigators, should thus be looked upon as one of the most fruitful sources of the so-called "surprising experimental results." In the first place the average titer of a pooled sample is difficult to foretell. It may be high or low depending on the predominance of sera of correspondingly high or low titer. Thus, if the reactor sera listed in Table 2 were pooled their average titer might be equal to that of the nonreactor serum, as claimed by Ruediger (1910) and Hall (1933), or it might be slightly higher (Ward and Wood, 1912). Similar contrasting results might likewise be obtainable from a pooled sample of the hyperimmune sera shown in Table 3. Furthermore, the correlation of the average titer to the original reaction of the serum producers is obviously difficult or confusing. This is especially true when so many variable factors, such as temperature and visible clinical symptoms (catarrh, stomatitis, and diarrhœa) are considered in the interpretation of such reaction.

Another source of confusion is in the use of excessive amounts of serum. As seen in Table 1, a dose of 100 cc of nonreactor serum per 100 kilos body weight prevented the development of any reaction. Such result cannot certainly be improved by any reactor or hyperimmune serum. Hence, it would appear that the determination of the minimal protective dose of any antirinderpest serum should precede the assessment of its relative efficacy; otherwise the latter loses its significance and value.

So, Stewart (1935), after having observed that field sera manufactured by the process of selecting serum makers on the basis of visible or severe reactions were of varying potency, decided to adopt the thermal response alone as the basis of selection. He used only serum from bovines that had a rise

in temperature of 2° F. above normal for at least two days. As a result he reduced the losses from 6 per cent (when visible clinical symptoms were considered in the selection) to only 1.97 per cent, among 13,580 and 10,047 animals, respectively.

Stewart has thus indicated that the thermal reaction of the serum producer has a direct influence on the titer of its serum. This is corroborated by the results displayed in Table 2, although they also show that a satisfactory reaction in one place may not be the same for another. Under Philippine conditions a thermal reaction of 40° C. or over for at least four days seems to be most suitable for the production of the highest titer in the reactor sera.

That a marked thermal reaction is accompanied by the production of an immune serum of highest titer is thus demonstrated. But as to whether a "maximum titer" is attained after such preliminary reaction to the virus inoculation is still a controversial point. Edwards (1925) claims that such titer is reached, no matter whether the reaction is "blocked-out," "nearly blocked-out," or "mild, but decided;" but Rabagliati (1928) and Bennett (1934) demonstrated that the titer of a pooled reactor serum is invariably increased after hyperimmunization. The data presented in Table 3, however, do not seem to give unequivocal support to either of the above observations. On the other hand the results show that hyperimmunization caused only a noticeable increase in the titer of a marked reactor serum (TR–3541) whose titer was allowed to lapse, and of a mild serum (TR–3585), but such effect was practically nil on marked reactor sera, TR–3403 and TR–3566. The results obviously tend to prove that a maximum titer has already been attained prior to hyperimmunization in the last two marked reactor sera, which was not the case in the first two sera (see text fig. 11).

The following observations, therefore, may be derived from Table 3: (*a*) Hyperimmunization, like any other biological procedure, has its limitations, which should not be ignored in order that its usefulness may not be unduly exaggerated; (*b*) the use of 7 cc of virulent blood per kilo body weight was followed by the production of a relatively higher titer (see HI–3541 and HI–3566) than the use of an equivalent dose of 17 to 19 cc (see HI–3585 and HI–3403); this apparently means that the optimum (?) amount of virus was already present in the smaller dosage and that any excess had no beneficial effect, and if it had

any at all, it was harmful; (*c*) there seems to be a direct relationship between the thermal reaction noted in the temperature charts of hyperimmune serum producers HI–3541 and HI–3585 (figs. 7 and 8), and antibody production; that such behavior was not merely accidental is indicated by the absence of similar reactions in the temperature charts of hyperimmune serum pro-

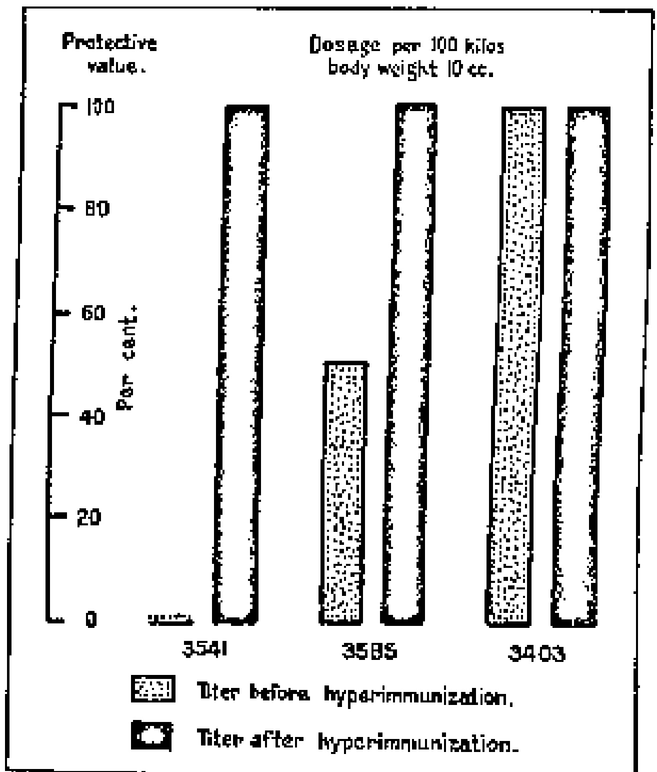

FIG. 11. Showing the effect of hyperimmunization on the titer of antirinderpest reactor immune sera (see Tables 2 and 3).

ducers HI–3403 and HI–3566 (figs. 9 and 10). Observations *b* and *c*, however, require further experimental inquiry before definite conclusions can be drawn concerning them.

SUMMARY

Experimental evidence has been obtained to show that antirinderpest nonreactor immune sera are definitely protective to Philippine cattle, if used in adequate amounts.

Mild reactor sera, or those derived from cattle which had developed a thermal reaction of 40° C. or lower for three days or less, when given in the dosage of 10 cc per 100 kilos body weight protected only one of five test animals; but marked reactor sera, or those derived from cattle which had developed a thermal reaction of 40° C. or higher for four days or more, when given in the same dosage protected six of seven animals.

Evidence has been obtained to show that the titer of a reactor serum varies in direct proportion to the degree and duration of the thermal reaction of the serum producer.

Hyperimmunization was observed to cause an appreciable increase in the titer of a marked reactor serum whose titer was allowed to lapse or of a mild reactor serum; but such effect was not apparent in marked reactor sera of undiminished titer.

Hyperimmune sera used in the dosage of 10 cc per 100 kilos body weight protected all of the four test animals, but in the equivalent dose of 5 cc they failed to protect in four of eight tests.

II. SERUM OF VACCINATED ANIMALS AND THE EFFECT OF VIRUS ON ITS POTENCY

Kakizaki (1925) and Daubney (1928) demonstrated by ordinary simultaneous inoculation tests in susceptible animals that sera of vaccinated animals possess some protective value against rinderpest virus. These results were, however, obtained from apparently infective vaccines. Whether similar results can be obtained from the use of a completely inactivated rinderpest vaccine may thus be determined by the following experiments. Likewise, the effect of virus inoculation into animals vaccinated with such vaccine may be studied.

EXPERIMENTAL DATA

VACCINE SERA

Experiment 1.—Vaccine serum 2260 was obtained from bull 2260, which was vaccinated with 5 cc of chloroform-treated rinderpest vaccine, S-144, March 8, 1933, and bled for serum March 17, 9 days after vaccination. (Control Dalupiri carabao 90, which was vaccinated with 10 cc of S-144 and injected with 2 cc of fresh virulent blood 2 weeks later, developed no reaction to the virus.)

Bull 2726 was injected simultaneously with 300 cc of vaccine serum 2260 (100 cc per 100 kilos body weight) and 2 cc of fresh virulent blood. This animal developed a severe rinderpest reaction and was finally killed for vaccine.

Experiment 2.—Vaccine serum 2232 was obtained from bull 2232, which was vaccinated with 20 cc of S–144 March 1, 1932, and bled for serum March 10, 9 days after vaccination.

Bull 2722 was injected simultaneously with 300 cc of the above serum (160 cc per 100 kilos body weight) and 2 cc of fresh virulent blood. This animal developed a severe rinderpest reaction and was finally killed for vaccine.

Experiment 3.—Vaccine serum 45 was obtained from Dalupiri carabao 45, which was vaccinated with 200 cc of chloroform-treated vaccine, S–166, October 18, 1933, and bled for serum October 28, 10 days after vaccination. (Control Dalupiri carabao 1284, which was likewise vaccinated with 10 cc of S–166 and inoculated with 2 cc of fresh virulent blood 2 weeks later, developed a temperature reaction but recovered.)

Bull 2813 was injected simultaneously with 1,500 cc of vaccine serum 45 (670 cc per 100 kilos body weight) and 2 cc of fresh virulent blood. This animal developed a severe rinderpest reaction and was finally killed for vaccine.

Experiment 4.—Vaccine serum 70 was obtained from Dalupiri carabao 70, which was vaccinated with 200 cc of chloroform-treated vaccine S–169 November 29, 1933, and bled for vaccine serum December 9, 10 days after vaccination. (Control Dalupiri carabao 66, which was likewise vaccinated with 10 cc of S–169 and inoculated with 2 cc of fresh virulent blood 2 weeks later, developed a temperature reaction but recovered.)

Bull 2014 was injected simultaneously with 2,000 cc of vaccine serum 70 (760 cc per 100 kilos body weight) and 2 cc of fresh virulent blood. This animal developed a severe rinderpest reaction and was finally killed for vaccine.

VACCINE SERA (PLUS VIRUS)

Experiment 5.—Vaccine serum 3409 (plus virus) was obtained from bull 3409, which was vaccinated with 10 cc of glycerine-formolized rinderpest vaccine September 24, 1934; inoculated with 1 cc of fresh virulent blood October 10; developed no reaction to the virus; and finally was bled for serum November 5, 26 days after virus inoculation.

Bull 3523 was injected simultaneously with 103 cc of the above serum (40 cc per 100 kilos body weight) and 1 cc of fresh virulent blood 3495. This animal developed only a high thermal reaction for 2 days. (Control bull 3459, which was inoculated with 1 cc of virulent blood 3495, developed a severe rinderpest reaction, and finally was killed for vaccine.)

Experiment 6.—Vaccine serum 3510 (plus virus) was obtained from bull 3510, which was vaccinated with 0.5 g of dried rinderpest vaccine October 24, 1934; inoculated with 1 cc of fresh virulent blood November 7; developed no reaction to the virus; and finally was bled for serum November 29, 22 days after virus inoculation.

Bull 3503 was injected simultaneously with 94 cc of the above serum (40 cc per 100 kilos body weight) and 2 cc of fresh virulent blood 3514. This animal developed a high thermal reaction for 6 days and recovered. (Control bull 3586, which was inoculated with 2 cc of virulent blood 3514, developed a severe rinderpest reaction and finally was killed for vaccine.)

TABLE 4.—*Summary of experiments.*

Experiment No.	Material used. Vaccine serum No.	Amount.	Bull No.	Results after virus inoculation.
		cc.		
1	2240	300	2726	Severe rinderpest reaction.
2	2232	300	2722	Do.
3	45	1,500	2813	Do.
4	70	2,000	2914	Do.
5	3409 (plus virus)	103	3523	High thermal reaction for 2 days.
6	3510 (plus virus)	94	3503	High thermal reaction for 6 days.

COMMENT

The results of experiments 1 to 4 show that completely inactivated but potent rinderpest tissue vaccines were unable to produce sera of demonstrable protective value against rinderpest virus. It is thus evident that the type or degree (?) of immunity developed by such vaccines is quite different from that engendered by an infective one, or another that may contain living virus in subinfective doses. The presence of unmodified active rinderpest virus in the tissue vaccine, therefore, may be looked upon as superfluous and a source of danger for the infection that it may produce in some vaccinated animals; for without such active virus the vaccine still retains its full immunizing property.

On the other hand, the results of experiments 5 and 6 demonstrate that the inoculation of living rinderpest virus into vaccinated animals, even if "no reaction" resulted from such inoculation, was invariably followed by the production of an "immune serum" of definite immunizing property. Similar results were observed in other experiments not included herein. Likewise the results obtained by Kakizaki (1925) and Daubney (1928) on vaccine sera apparently fall in the same category.

Thus, the moot question of whether the rinderpest tissue vaccine owes its immunizing property to a dead or to a subinfective dose of living virus has been partially answered by the preceding experiments. Certainly its inability to produce an "immune serum" makes it evident that such vaccine does not contain an unmodified living rinderpest virus.

SUMMARY

Experimental evidence has been obtained to show that a completely inactivated rinderpest tissue vaccine was unable to pro-

duce a serum of demonstrable protective value. However, the inoculation of living rinderpest virus into vaccinated animals, even if "no reaction" resulted from such inoculation, was invariably followed by the production of an "immune serum" of definite immunizing property.

III. THE SPLEEN AND LYMPH GLANDS OF RINDERPEST-RECOVERED ANIMALS FOR IMMUNIZATION

The efficacy of vaccines prepared from the spleen and lymph glands of rinderpest-infected animals (killed at the height of the disease) by proper inactivation of the virus with chemicals or by desiccation has been demonstrated by many investigators (Kakizaki et al., 1928; Kelser et al., 1928; Jacotot, 1932; Robles and Generoso, 1933; and others). Yet, whether such vaccines owe their immunizing value to the inactivated or dead rinderpest virus or to other substances contained in the organs used is still a matter of conjecture.

Jacotot (1932) demonstrated that avirulent blood, peritoneal fluid, and abomasal mucosa obtained from rinderpest-infected animals do not possess any immunizing value. Hence, he believes that the vaccinating property of certain organs is not due to the virus but to a "fragile substance," which can be stabilized by dehydration or treatment with chemicals. When this substance is inoculated it fixes itself to the cellular elements sensitive to the rinderpest virus; its rôle is thus purely passive. Saceghem (1933) calls this substance a "toxin," which he believes to be transformed into an anatoxin (toxoid) by the addition of formalin. Kelser et al. (1928), being unable to obtain any immunizing value from blood rich in rinderpest virus, likewise suggest that the immunizing principle contained in certain organs is "either some biproduct of the reaction between tissue and virus or rinderpest virus that has been changed in some particular way by the activity of the solid tissues." Boynton (1935), on the other hand, believes that a tissue vaccine, like the rinderpest vaccine, apparently owes its immunizing property not to the killed virus, but to a "modified living virus" (modified by chemicals) that has lost its disease-producing power but still retains its ability to stimulate antibody formation in the animal body.

All of the above presumptions are apparently based upon mere inferences from negative experimental results. The reason is

obvious; and as long as we keep on using composite tissue vaccines and are unable to cultivate in pure culture the virus of rinderpest, the true nature of the immunizing substance in the vaccine will remain indeterminate.

Nevertheless, an attempt will be made in the following experiments to demonstrate whether or not the spleen and lymph glands of rinderpest-recovered cattle possess any immunizing value (active or passive).

MATERIALS AND METHODS

EXTRACTS OF SPLEEN AND LYMPH GLANDS FROM RINDERPEST-RECOVERED ANIMALS

No. 3259.—Fuga bull 3259 was vaccinated with 0.5 g of dried rinderpest vaccine September 19, 1934; inoculated with 1 cc of virulent blood October 3; and finally developed a high thermal reaction for 3 days (October 7 to 9). The spleen and lymph glands were removed November 11, 38 days after virus inoculation.

No. 3403 (hyperimmunized).—Fuga bull 3403 was vaccinated with 10 cc of glycerine-formolized rinderpest vaccine September 27, 1934; inoculated with 1 cc of fresh virulent blood October 10; developed a high thermal reaction for 6 days; and was hyperimmunized with 4,000 cc of fresh virulent blood November 7 and a similar amount November 14. The spleen and lymph glands were removed December 10, 26 days after the last massive virus injection.

No. 3623.—Fuga bull 3623 (fig. 12) was inoculated with 10 cc of virulent blood August 7, 1935, and subsequently developed a high thermal reaction for 6 days (August 10 to 15). The spleen and lymph glands were removed August 22, 15 days after virus inoculation (6 days after the temperature had dropped below 40° C.).

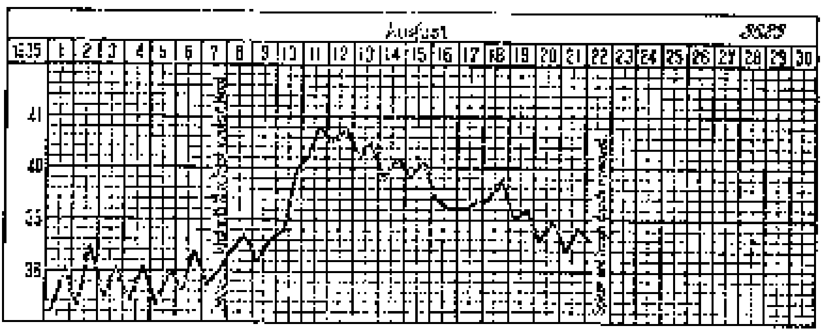

FIG. 12. Temperature chart of rinderpest-recovered bull whose spleen and lymph glands were used in the preparation of organ extract 3623.

No. 3647.—Fuga bull 3647 (fig. 13) was injected simultaneously with 10 cc of hyperimmune serum and 2 cc of virulent blood August 14, 1935, and subsequently developed a high thermal reaction for 5 days (August 18 to 22). The spleen and lymph glands were removed August 28, 14 days after virus inoculation (5 days after the temperature had dropped below 40° C.).

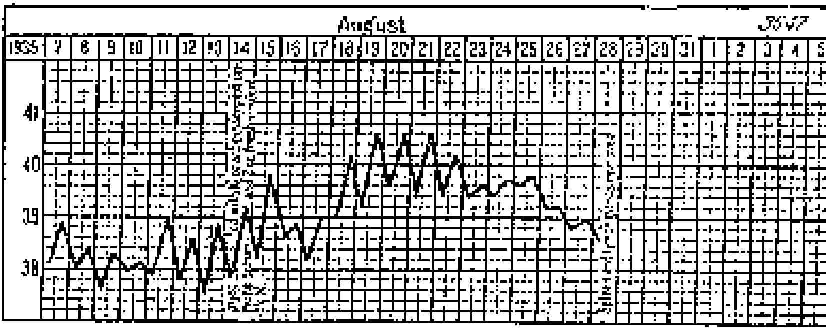

FIG. 13. Temperature chart of rinderpest-recovered bull whose spleen and lymph glands were used in the preparation of organ extract 3647.

No. 3675.—Romblon bull 3675 (fig. 14) was injected simultaneously with 70 cc of immune serum and 2 cc of virulent blood September 25, 1935, and subsequently developed a high thermal reaction for 4 days (September 29 to October 2). The spleen and lymph glands were removed October 10, 15 days after virus inoculation (7 days after the temperature had dropped to 40° C.).

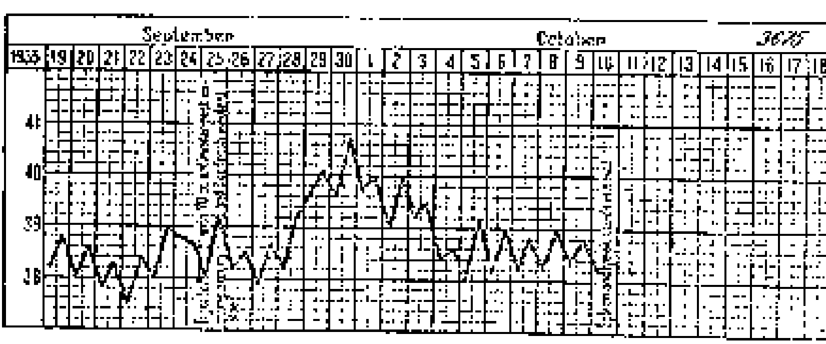

FIG. 14. Temperature chart of rinderpest-recovered bull whose spleen and lymph glands were used in the preparation of organ extract 3663 3675.

No. 3663.—Romblon bull 3663 (fig. 15) was injected simultaneously with 10 cc of immune serum and 2 cc of virulent blood September 25, 1935, and subsequently developed a high thermal reaction for 4 days (September 30 to October 3) and diarrhœa for 3 days. The spleen and lymph glands were removed October 10, 15 days after virus inoculation (7 days after the temperature had dropped to 40° C.).

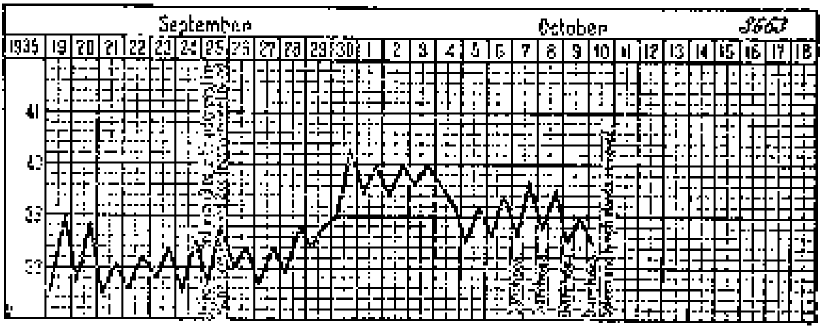

FIG. 15. Temperature chart of rinderpest-recovered bull whose spleen and lymph glands were used in the preparation of organ extract 3661-3675.

PREPARATION OF ORGAN EXTRACTS

The spleen and lymph glands that were removed from each animal were trimmed of their fat and fascia, disinfected with 5 per cent phenol for 10 minutes, rinsed with water, and cut into thin slices. These were steeped overnight in sterile physiological saline, which was subsequently discarded so as to remove whatever traces of immune serum or fluids were present in the tissues. They were then ground in a meat chopper, triturated in a mortar, and strained through 18-mesh wire gauze. To the strained pulp distilled water was added so as to make a 20 per cent suspension. The mixture was then shaken thoroughly with glass beads and stored at 0° to 3° C. for 24 hours, after which it was filtered by trituration through 50-mesh wire gauze. The filtrate obtained was a thick reddish brown liquid, and the residue that was discarded consisted largely of connective-tissue capsules and trabeculæ.

METHOD OF TESTING THE ORGAN EXTRACTS

Susceptible cattle were subcutaneously injected with 500 cc of the freshly prepared organ extracts (containing approximately 80 grams of tissue pulp) and then inoculated with 2 cc of fresh virulent blood, either simultaneously or 7 to 54 days later. Animals that developed a clinical rinderpest reaction accompanied by diarrhœa were declared to have had a severe rinderpest reaction, and those that had only a thermal reaction or no reaction were recorded.

EXPERIMENTS AND RESULTS

Experiment 1.—Organ extract 3250 was injected in 500-cc amounts into Mindoro bulls 3522 and 3515. The former was inoculated simultaneously with 2 cc of virulent blood and the latter 7 days later.

Both of the above animals developed severe rinderpest reactions.

Experiment 2.—Organ extract 3403 was injected in 500-cc amounts into Fuga bulls 3579, 3576, and 3577. These animals were inoculated with 2 cc of virulent blood, simultaneously, 10 days later, and 21 days later, respectively.

The first two animals developed severe rinderpest reactions, while the last (inoculated with virus 21 days later) developed only a high thermal reaction for 2 days.

Experiment 3.—Organ extract 3623 was injected in 500-cc amounts into Romblon bulls 3657 and 3654. The former was inoculated simultaneously with 2 cc of virulent blood and the latter 14 days later.

Bull 3657 developed a severe rinderpest reaction, while No. 3654 developed only a low thermal reaction for 5 days.

Experiment 4.—Organ extract 3647 was injected in a 500-cc amount into Romblon bull 3648, simultaneously with 2 cc of virulent blood.

The above animal developed a severe rinderpest reaction.

Experiment 5.—Organ extracts 3663 and 3675 were pooled and inoculated in 500-cc amounts into Fuga bulls 3550, 3560, 3557, and 3687. The first two were inoculated with virus 14 days later and the last two 54 days later.

Bulls 3550, 3560, and 3557 developed a high thermal reaction for 5, 4, and 3 days, respectively. Bull 3687 developed a severe rinderpest reaction.

TABLE 5.—*Summary of experiments and results.*

Experiment No.	Organ-extract No.	Manner of testing with virus.	Bull No.	Results after virus inoculation.
1	3250	Simultaneously	3522	Severe rinderpest reaction.
1	3250	Seven days later	3515	Do.
2	3403	Simultaneously	3579	Do.
2	3403	Ten days later	3576	Do.
2	3403	Twenty-one days later	3577	High thermal reaction for 2 days.
3	3623	Simultaneously	3657	Severe rinderpest reaction.
3	3623	Fourteen days later	3654	Low thermal reaction for 5 days.
4	3647	Simultaneously	3648	Severe rinderpest reaction.
5	3663-3675	Fourteen days later	3550	High thermal reaction for 5 days.
5	3663-3675	do	3560	High thermal reaction for 4 days.
5	3663-3675	Fifty-four days later	3557	High thermal reaction for 3 days.
5	3663-3675	do	3687	Severe rinderpest reaction.

COMMENT

The results of experiments 3 to 5 show that the spleen and the lymph glands of rinderpest-infected animals were no longer virulent on the fifth or seventh day after the temperature had dropped below 40° C., 14 to 15 days after virus inoculation (text figs. 12 to 15). This behavior is quite similar to that of the blood,

for Ward et al. (1914) record a rinderpest case whose blood proved noninfective on the thirteenth, fifteenth, seventeenth, nineteenth, and twenty-first days after virus inoculation. Todd (1930) likewise states that the appearance of rinderpest virus in the blood seems to coincide with the period of fever and disappears normally with the subsidence of temperature. However, in spite of their noninfectivity, the same spleen and lymph glands demonstrated some immunizing power, provided that an interval of at least 7 days was allowed to elapse before a test dose of virus was given; but not when the virus was inoculated simultaneously.

The behavior of the immunizing substance contained in those organs is thus similar to that of an antigen but unlike that of antibodies; and it seems to diminish quite rapidly after an acute rinderpest infection, as organs obtained 14 to 15 days after virus inoculation (experiments 3 to 5) indicated a higher protective power than those obtained 26 to 33 days later (experiments 1 and 2). It may be presumed, therefore, that the antigen concentration in the spleen and lymph glands of rinderpest-infected animals is at its highest 6 to 7 days after virus inoculation, as tissue extracts prepared at this period have been commonly observed to give the best results. Besides, such antigen seems to be either a residual "changed virus" or a "reaction product" (a toxin as suggested by Saceghem) between virus and tissues, but obviously not an "unmodified living virus," otherwise the inoculated animals would not have been susceptible to the test dose of virulent blood (experiments 1 to 5).

SUMMARY

The spleen and lymph glands of rinderpest-infected animals, 5 to 7 days after the subsidence of temperature below 40° C. or 14 to 15 days after virus inoculation, were no longer virulent. However, extracts prepared from them and injected in 500-cc (20 per cent emulsion) amounts were able to protect four of five test animals, when followed by virus inoculation 14 to 54 days later; but when simultaneously injected with virulent blood, they failed to show any protective value.

The immunizing substance contained in the spleen and lymph glands of rinderpest-infected animals seems to be some form of antigen, which disappears quite rapidly after an acute rinderpest reaction, as organ extracts obtained 26 to 33 days after virus inoculation protected only one of three test animals, when followed by virus 7 to 21 days later.

ACKNOWLEDGMENT

The writer wishes to thank Drs. T. Topacio and J. D. Generoso, chief and assistant chief of the Veterinary Research Division, respectively, for their encouragement and generous attitude towards the pursuance of these studies.

REFERENCES

BENNETT, S. C. J. Immune and hyperimmune cattle plague antiserum. Journ. Comp. Path. and Therap. 57 (1934) 163–180.

BOYNTON, W. H. Immunization against virus diseases with tissue vaccine. Journ. Am. Vet. Med. Assoc. 40 (1935) 650–658.

CARMICHAEL, J. Anti-rinderpest serum—preliminary field research in Uganda. Journ. Comp. Path. and Therap. 41 (1928) 185–190.

DAUBNEY, R. Observations on rinderpest. Journ. Comp. Path. and Therap. 41 (1928) 263–297.

EDWARDS, J. T. From the report of the Imperial Bacteriological Laboratory, Muktesar, India, for the two years ended 31st March 1924. Journ. Comp. Path. and Therap. 38 (1925) 120–135.

JACOTOT, H. On antiseptic vaccination with a virulent extract of the organ pulp. (Translated.) Ann. de l'Inst. Pasteur 48 (1932) 744–783.

KAKIZAKI, C. Experimental studies on the prophylactic inoculation against rinderpest. Third Report of the Government Institute for Veterinary Research, Fusan, Chosen (1925) 1–48.

KAKIZAKI, C., S. NAKANISHI, and T. OIZUMI. III. Experimental studies on prophylactic vaccination against rinderpest. Fourth Report of the Government Institute for Veterinary Research, Fusan, Chosen (1927) 1–46.

KAKIZAKI, C., S. NAKANISHI, J. NAKAMURA, and Y. YOSHIJOMA. Experiments on the rinderpest vaccine. Journ. Japanese Soc. Vet. Sci. 7 (1928) 207–218.

KELSER, R., S. YOUNGBERG, and T. TOPACIO. An improved vaccine for immunization against rinderpest. Philip. Journ. Sci. 36 (1928) 373–395.

RABAGLIATI, D. S. The potency of anti-cattle plague serum. Journ. Comp. Path. and Therap. 38 (1925) 204–213.

ROBLES, M. M., and J. D. GENEROSO. Dried rinderpest vaccine. Philip. Journ. Animal Ind. 1 (1934) 33–44.

RUEDIGER, E. H. The production of immune bodies without reaction after inoculation with cattle-plague blood. Bull. Manila Med. Soc. 2 (1910) 264–265.

SACEGHEM, R. VAN. The action of serum and the nature of vaccine utilized against rinderpest. (Translated.) Bull. Société de Path. Exotique 26 (1933) 715–720.

STEWART, J. L. Immune cattle plague antiserum manufactured in the field. Journ. Comp. Path. and Therap. 48 (1935) 117–124.

TODD, C., and R. G. WHITE. Experiments on cattle plague. From the Hygienic Institute, Dept. of Public Health, Cairo (1914) 1–133.

TODD, C. Cattle Plague. A System of Bacteriology in Relation to Medicine. His Majesty's Stationery Office, London 7 (1930) 284–301.

TOPACIO, T. The manufacture of anti-rinderpest serum in the Philippine Islands. Philip. Agr. Rev. 15 (1922) 229–236.

WARD, A. R., and F. W. WOOD. Experiments on the efficiency of antirinderpest serum. P. I. Bur. Agr. Bull. 19 (1912) 1–109.

WARD, A. R., F. W. WOOD, and W. H. BOYNTON. Experiments upon the transmission of rinderpest. P. I. Bur. Agr. Bull. 30 (1914) 1–31.

ILLUSTRATIONS

TEXT FIGURES

IMMUNITY IN RINDERPEST-VACCINATED ANIMALS

By T. TOPACIO and M. M. ROBLES
Of the Bureau of Animal Industry, Manila

Rinderpest immunity after vaccination appears to have been first studied by Kakizaki (1925), who demonstrated that the serum of vaccinated animals apparently possesses some protective value when inoculated into susceptible animals. This was confirmed by Daubney (1928). On the other hand, Robles (in this issue) failed to verify such finding when he used a completely inactivated dried-tissue vaccine, but he indicated that the serum of vaccinated animals acquires a definite immunizing property when vaccination is followed by virus.

However, no reference is available to show that cellular immunity after inoculation of rinderpest-tissue vaccine has ever been investigated. Thus, it is the object of the present study to determine whether or not the cells of the lymph glands of rinderpest-vaccinated animals possess any power of destroying or neutralizing the virus of rinderpest.

The possibility of such behavior has been suggested by the work of Levaditi (cited by D'Herelle, 1924), who after passing vaccinia virus many times through the brains of rabbits obtained a true "fixed" vaccinia virus, which causes a fatal meningitis; however, if such a virus is introduced into the brain of a previously vaccinated rabbit, it is quickly destroyed, so that after some hours it can no longer be demonstrated. Levaditi has thus shown that "it is the susceptible cells which acquire the immunity and that this immunity is due to the fact that these cells are able to destroy the virus."

Since the announcement by Besredka (1927) a decade ago that immunity may be established without the obligatory participation of antibodies, a field was opened which culminated in the investigation of various mechanisms in the immunity involved in various infectious diseases. In the light of this new concept some of the most important recent advances in vaccine therapy have tended to converge into Besredka's theory of local immunization. Vaccination against vaccinia, smallpox, fowl pox, foot-and-mouth disease, and anthrax may be cited.

The results of his classical experiments on anthrax cuti-immunization, the oral vaccination against dysentery and typhoid, and the application of antivirus dressings on the skin against the staphylococcus and streptococcus infections were far-reaching and deserve further confirmation or repudiation before we pass upon them lightly. Intradermal immunization against anthrax with the spore vaccine is now an accepted fact, and hundreds upon thousands of animals in Europe and America have already been vaccinated by this method with good results.

More recently Gochenour et al. (1935) reported that in the testing of the various types of anthrax vaccine produced in the United States by commercial houses the intradermal spore vaccine administered in 0.5 cc doses has given the most enduring immunity. Likewise, it is widely known that immunity in rabies vaccination, whether with virulent or killed fixed virus, is generally followed by the ability of the vaccinated animals to resist subdural injection of virulent fixed brain virus, showing again the specific immunity conferred on the nerve cells. Such cellular immunity has been observed in other infections, but the above list suffices to demonstrate the existence of this immunity mechanism.

MATERIALS AND PROCEDURE

Vaccinated animals.—Cattle and carabaos were vaccinated intramuscularly on the left side of the back just behind the shoulder blade with varying amounts of dried rinderpest vaccine as follows:

	g.
Fuga bull 3553	0.5
Fuga bull 3550	1.0
Fuga bull 3558	1.0
Fuga bull 3680	5.0
Fuga bull 3684	5.0
Dalupiri carabao 1409	2.5
Dalupiri carabao 1412	10.0
Dalupiri carabao 1402	10.0

Two weeks after vaccination, when immunity was already established, the animals were subjected to intraglandular inoculation of virulent blood.

Technic of intraglandular virus inoculation.—The vaccinated animal was properly restrained on an operating table. The right precrural lymph gland was exposed by a cutaneous incision and careful dissection. One-half cubic centimeter of fresh citrated virulent blood was then introduced into the gland substance by means of a 23-gauge hypodermic needle. The point

of inoculation was immediately cauterized with a hot spatula so as to avoid the escape of blood outside the gland. The skin wound was finally sutured and the wound dressed with sterile vaseline or ether-collodion. All animals that received the intraglandular virus inoculation were isolated and observed for two weeks.

Testing the virus-infected gland.—Twenty-four hours after virus inoculation the lymph gland was dissected out, trimmed of its connective-tissue capsule, ground finely in a meat grinder, triturated in a mortar with 100 cc of sterile distilled water, and filtered through a double thickness of gauze. The filtrate was then injected subcutaneously into susceptible animals. These were also observed for two weeks, and if not infected were released for the final susceptibility tests.

Testing the serum obtained after intraglandular virus inoculation.—Sera from four vaccinated animals were obtained fourteen days after the intraglandular virus inoculation and tested for their protective value against rinderpest virus in highly susceptible cattle.

EXPERIMENTS AND RESULTS

EXPERIMENTS ON THE VIRUS-INFECTED GLANDS

Experiment 1.—Bull 3553 was vaccinated February 26, 1935, and received 0.5 cc of fresh virulent blood intraglandularly two weeks later. There was no reaction to the virus. Its gland extract was injected into Fuga bull 3548, but no evidence of infection appeared.

Control.—Bull 3568 (unvaccinated) was inoculated in the same manner with 0.5 cc of the blood used above. Its gland extract proved infective to Fuga bull 3545.

Experiment 2.—Bulls 3555 and 3558 were vaccinated March 27, 1935, and both were inoculated intraglandularly with 0.5 cc of virulent blood two weeks later. As a result the former developed no reaction and the latter showed a marked thermal reaction for five days followed by recovery. The gland extract obtained from bull 3555 was injected into Romblon bull 3631 (2a) but proved avirulent, while the gland extract obtained from bull 3558 proved infective to Romblon bull 3633 (2b).

Experiment 3.—Fuga bulls 3630 and 3654 were vaccinated October 23, 1935 and inoculated intraglandularly with 0.5 cc of blood four weeks later (November 26); neither developed a reaction to the virus. Their gland extracts when injected into Fuga bulls 3674 and 3677, respectively, proved avirulent.

Experiment 4.—Dalupiri carabao 1409 was vaccinated September 18, 1935 and inoculated intraglandularly with 0.5 cc of fresh virulent blood two weeks later; it developed a high thermal reaction for five days but recovered. Its gland extract when injected into Fuga bull 3081 proved infective.

Control.—The gland extract from Dalupiri carabao 1407 (unvaccinated), which was treated in the same manner as No. 1409, proved infective to Fuga bull 3679.

Experiment 5.—Dalupiri carabaos 1402 and 1412 were vaccinated October 23, 1935 and inoculated intraglandularly with 0.5 cc virulent blood four weeks later (November 26); developed no reaction to the virus. Their gland extracts when injected into Fuga bulls 3667 and 3665, respectively, proved avirulent.

TABLE 1.—*Summary of experiments 1 to 5.*

Experiment No.	Test animal No.	Gland No.	Type of gland.	Result after gland-extract injection.	Result after injection of 1 cc virulent blood.
1	3548	3553	Vaccinated	Not infected	Typical rinderpest.
	3545	3568	Control	Infected	
2a	3631	3556	Vaccinated	Not infected	Do.
2b	3633	[a]3558	do	Infected	
3a	3674	3680	do	Not infected	Do.
3b	3677	3684	do	do	Do.
4	3681	[a]1409	do	Infected	
	3679	1407	Control	do	
5a	3667	1402	Vaccinated	Not infected	Do.
5b	3665	1412	do	do	Do.

[a] Developed five days of thermal reaction after intraglandular virus inoculation.

EXPERIMENTS ON THE SERUM OBTAINED AFTER INTRAGLANDULAR VIRUS INOCULATION

Experiment 6.—Fuga bulls 3680 and 3684 (in experiment 3) were vaccinated October 23, 1935 and inoculated with fresh virulent blood four weeks later (November 26); neither developed a reaction to the virus. December 10 each of these animals was bled for serum, which was separately injected, in 200-cc amounts together with 2 cc of fresh virulent blood, into Fuga bulls 3689 and 3682, respectively. Neither of these animals developed any reaction, showing that the serum was protective.

Experiment 7.—Dalupiri carabaos 1402 and 1412 (in experiment 5) were vaccinated October 23, 1935 and inoculated with fresh virulent blood four weeks later (November 26); neither developed any reaction to the virus. December 10 each of these animals was bled for serum, which was separately injected, in 200-cc amounts together with 2 cc of fresh virulent blood, into Fuga bulls 3691 and 3695, respectively. The former failed to develop a reaction to the virus; while the latter, No. 3695, which was injected with the serum of Dalupiri carabao 1412, developed a severe rinderpest reaction.

Control.—Fuga bull 3693, which was inoculated with 2 cc of fresh virulent blood used in experiments 6 and 7, likewise developed a severe rinderpest reaction.

COMMENT

The virulent blood introduced into the lymph gland in the preceding experiments may be divided into two parts; namely, residual and circulating. The first, as its name would indicate,

remains in the gland substance, while the latter goes into the general circulation.

As shown by the infectivity of lymph glands from unvaccinated animals (controls), there remains a sufficient amount of residual rinderpest virus in the gland after a lapse of twenty-four hours. This is true for both cattle and carabaos. But in the lymph glands of vaccinated animals such residual virus appears to have been completely or partly destroyed. The destruction was complete when the vaccine immunity was of a high order, as in the vaccinated animals that developed no reaction to the intraglandular virus inoculation; or incomplete, when the immunity was of a low order as in the animals that developed a thermal reaction (see experiments 2b and 4). It appears that the degree of cellular and local immunity present in the lymph glands may be taken as a measure of the general immunity established in the animal.

It should be noted that all test animals that were not infected by the lymph-gland extract inoculation later proved to be susceptible to rinderpest. This behavior suggests that all traces of residual virus (sufficient to cause "inapparent infection") have been disposed of and completely destroyed by the glands.

On the other hand it will be noted that the serum of vaccinated animals apparently does not contain antiviral bodies. This is shown in experiments 6 and 7, wherein the inability of the animal to destroy the circulating fraction of the inoculated virus led to the production of an "immune" serum. These results confirm the work of Robles (in this issue) that the sera of vaccinated animals possess no protective value.

In view of the preceding considerations, we are led to believe that the immunity induced by vaccination with completely inactivated rinderpest-tissue vaccines is largely, if not wholly, a local cellular immunity which resides in the lymph glands and perhaps in other lymphoid organs of the body. Since immunity in vaccinated animals is not permanent and the fact that the serum obtained from them does not seem to have any demonstrable protective value, it appears that immunity in these cases may be either a simple fortified passive immunity or a very low degree of active immunity.

SUMMARY

Experimental evidence has been obtained to show that the lymph glands of rinderpest-vaccinated cattle and carabaos possess the ability of neutralizing the rinderpest virus in vivo.

This may be taken as a measure of the degree of general immunity produced in the animal body.

The immunity induced in vaccinated animals appears to be purely local and cellular in character, as shown by the ability of their lymph glands to neutralize the virus completely when it remains in those organs. The lack of protective value of the serum of vaccinated animals sustains the belief that a humoral immunity is not operating. It is very likely a form of fortified passive immunity or a very low degree of active immunity, which resides in the lymph glands and other lymphoid organs of the body.

The serum of vaccinated animals does not contain antiviral bodies. This was indicated by its inability to neutralize the rinderpest virus that gained entrance into the circulation and thereby permitted the production of a protective "immune" serum.

REFERENCES

BESREDKA, A. Local Immunization. The Williams and Wilkins Co., Baltimore (1927) XI+181 pp.

DAUBNEY, R. Observations on rinderpest. Journ. Comp. Path. & Therap. 41 (1928) 263-297.

D'HERELLE, F. Immunity in Natural Infectious Diseases. (Authorized English edition.) Williams and Wilkins Co., Baltimore (1924) 1-399.

GOCHENOUR, W. S., et al. Efficacy of anthrax biologics in producing immunity in previously unexposed animals. U. S. Dept. Agr. Tech. Bull. 468 (1935) 1-15.

KAKIZAKI, C. Experimental studies on the prophylactic inoculation against rinderpest. Third Rept. Govt. Inst. Vet. Research, Fusan, Chosen (1925) 1-48.

ROBLES, M. M. Rinderpest studies. (In this issue.)

STUDIES ON THE CERCARICIDAL PROPERTY OF THE SERA OF VERTEBRATE ANIMALS [1]

By MARCOS A. TUBANGUI and VICTORIA A. MASILUÑGAN
Of the Bureau of Science, Manila

One of the most recent contributions to our knowledge of the properties of the normal sera of vertebrate animals is that of Culbertson and Talbot (1935) on the antagonistic action exhibited by some of these fluids against the cercarial stages of trematode parasites. According to these writers, the cercaricidal test would be useful in the determination of the complete cycles of these larval forms if evidence could be obtained to show that a relationship exists between the cercaricidal power of the serum of an animal and the resistance of that animal to infection with a given cercaria. The present studies were undertaken partly for the purpose of extending the observations of Culbertson and Talbot and partly in order to inquire into the probable mechanism of the cercaricidal action.

MATERIAL AND METHODS

Two species of cercariæ were used in the experiments; namely, the cercaria of the blood fluke, *Schistosoma japonicum*, and *Cercaria mailimensis* Tubangui, 1928. Only mature actively swimming larvæ were utilized in the tests. Larval specimens of *C. mailimensis* were obtained by exposing infected snails [*Pila luzonica* (Reeve)] in the sun for a few minutes in order to stimulate the parasites to crawl out into the water. In the case of the cercaria of *Schistosoma japonicum* the snails [*Schistosomophora hydrobiopsis* (Rensch)] were crushed in order to liberate the larvæ.

The serum samples were obtained from the following: Man, monkey, cow, carabao, sheep, goat, cat, rabbit, guinea pig, chicken, frog (*Rana vittigera*), and fish (*Ophiocephalus striatus*). Each serum was used either in the fresh or inactivated state and either pure or dilute. The inactivation was made by heating at 57° C. for 20 to 30 minutes on a water bath. In the prep-

[1] Received for publication June 5, 1936.

aration of serum dilutions ordinary artesian-well water was employed instead of physiological salt solution, for it was found that some cercariæ were very susceptible to salt solutions.

In carrying out the tests a volume of water containing the cercariæ was mixed with an equal volume of pure or dilute serum in a deep hollow slide or a small concave dish. The results were read after one hour incubation at 37° C. A serum was considered to possess cercaricidal property if after the period of incubation the cercariæ were found either dead or moribund and much deformed. The result of each test was checked by using a control consisting of a suspension of cercariæ either in water or inactivated serum. In many instances it was possible to foretell that one was dealing with a potent serum by the shedding of the tails of the cercariæ soon after being placed in contact with the serum. In negative tests the larvæ remained actively motile and normal in appearance at the end of the observation period in both the test and the control fluids.

CERCARICIDAL TESTS

The results of the cercaricidal tests are summarized in Table 1, which shows that the various sera, with the exception of those of the cat and the rabbit, possess some destructive effect on the two species of cercariæ used in the experiments. Against *C. maitimensis*, a distomid larva, the various sera were only

TABLE 1.—*Effect of the sera of different kinds of vertebrate animals on the cercaria of Schistosoma japonicum and Cercaria maitimensis.*

Kind of serum.	Species of cercaria.	
	C. schistosoma japonicum.	*C. maitimensis.*
Human	[a] + (1:2)	[a] ± (1:2)
Monkey	+ (1:2)	± (1:2)
Cow	+ (1:2)	± (1:2)
Carabao	+ (1:2)	± (1:3)
Sheep	+ (1:2)	± (1:2)
Goat	+ (1:2)	± (1:2)
Cat	± (1:2)	∓ (1:2)
Rabbit	—	—
Guinea pig	—	
Chicken	+ (1:4)	± (1:2)
Fish (*Ophiocephalus striatus*)	+ (1:4)	± (1:3)
Frog (*Rana vittigera*)	+ (1:10)	± (1:2)
	+ (1:88)	± (1:2)

[a] +, All cercariæ killed or rendered moribund and very much deformed; ±, some cercariæ killed or rendered moribund and very much deformed. —, cercariæ alive and normal. Figures in parentheses refer to the maximum titer of a serum against a particular species of cercaria.

partially antagonistic. This finding was probably to be expected, considering that this and related cercariæ do not introduce themselves into the bodies of their vertebrate hosts through the circulatory system. On the other hand, against the cercaria of *Schistosoma japonicum*, which is a blood parasite, the cercaricidal effect was quite marked, although the titers of the different sera varied between appreciably wide limits. The highest-titered sera were found to be those of the fish and the frog, which were potent in dilutions of 1 to 10 and 1 to 88, respectively. The titers of the other sera varied in dilutions between 1 to 2 and 1 to 4. Taking into account these differences and the fact that *Schistosoma japonicum* is not a parasite of cold-blooded vertebrates but of mammals, it appears from the results of the tests that there is an inverse relationship between the cercaricidal titer of the serum of an animal and the susceptibility of that animal to infection with the cercaria. The only exception noted is the low titer of the serum of the chicken, an animal which so far as known is not susceptible to infection with *Schistosoma japonicum*.

MECHANISM OF THE CERCARICIDAL ACTION

Our findings agree with those of Culbertson and Talbot to the effect that the substance in the serum responsible for the cercaricidal action is destroyed by heating and is quickly lost by the serum in storage. The fact that these are also characteristics of that component of the blood known as the complement suggested the probability of the cercaricidal reaction being analogous to the bacteriolytic and other cytolytic phenomena exhibited by normal sera. For this reason another set of experiments was carried out in order to inquire into the probable mechanism of the reaction. The results of the experiments are given in Tables 2, 3, and 4.

The results presented in Table 2 show that a serum like that of the guinea pig, which has lost its cercaricidal activity by heating, may be reactivated by the addition of a small amount of fresh potent serum. It is deduced from these results that the phenomenon involved is a "cercariolytic" reaction due, according to Ehrlich's side-chain theory, to a combination of antigen, amboceptor, and complement. In the experiment cited, the cercaricidal power of the guinea-pig serum was apparently lost due to the destruction of the complement by heating, but was restored when a very small amount of fresh guinea-pig serum was added. Identical results were obtained in parallel tests made

with human serum. Table 2, however, also shows that the reactivation of the heated serum was not accomplished when the fresh serum of either the cat or rabbit was added due to the fact that the sera of these two animals were found deficient in complement. By titrating these sera against an antimonkey hæmolytic system, as developed by Schöbl and Monserrat (1917) in the complement-fixation test for syphilis, it was determined that the titer of their complement was less than one-tenth of that of a normal guinea pig.

TABLE 2.—*Probable mechanism of the cercaricidal action: rôle of complement.*

Kind of serum.	Species of cercaria.	
	C. schistosoma japonicum.	*C. multi-[illegible]*
Inactivated guinea-pig serum	−	[illegible]
Inactivated human serum	[illegible]	[illegible]
Dilute, fresh guinea-pig serum (1:10)	[illegible]	−
Inactivated guinea-pig serum and dilute fresh guinea-pig serum (1:5), equal parts	[illegible]	[illegible]
Inactivated human serum and dilute fresh guinea-pig serum (1:5), equal parts	[illegible]	±
Inactivated guinea-pig serum and fresh rabbit serum, equal parts	−	−
Inactivated guinea-pig serum and fresh cat serum, equal parts	−	−

Table 3 shows that the sera of the cat and the rabbit failed to show any cercaricidal effect even when the amount of complement was increased by the addition of fresh guinea-pig serum. This observation gives the indication that the sera of these two animals are also deficient or are completely lacking in amboceptor.

TABLE 3.—*Probable mechanism of the cercaricidal activity: rôle of amboceptor.*

Kind of serum.	Species of cercaria.	
	C. schistosoma japonicum.	*C. multi-[illegible]*
Fresh cat serum	−	−
Fresh rabbit serum	−	−
Inactivated cat serum	[illegible]	−
Inactivated rabbit serum	[illegible]	−
Dilute, fresh guinea-pig serum (1:10)	[illegible]	[illegible]
Fresh cat serum and dilute fresh guinea-pig serum (1:5), equal parts	−	[illegible]
Fresh rabbit serum and dilute fresh guinea-pig serum (1:5), equal parts	−	−
Inactivated cat serum and dilute fresh guinea-pig serum (1:5), equal parts	−	−
Inactivated rabbit serum and dilute fresh guinea-pig serum (1:5), equal parts	−	−

TABLE 4.—*The cercaricidal titer of the serum of a guinea pig infected with Schistosoma japonicum compared with the titer of the serum of a normal guinea pig.*

Kind of guinea pig.	Serum dilution.							
	1:2	1:4	1:6	1:8	1:12	1:16	1:24	1:32
Normal	+	−	−	−	−	−	−	−
Infected	+	+	+	+	+	+	+	−

If the contention is correct that the cercaricidal property is analogous to the bacteriolytic, hæmolytic, and other cytolytic properties of the blood, then like the latter it should be subject to certain immunological processes. That it is is shown by the results of an experiment, the purpose of which was to find out if an increase in the amboceptor content of the blood could be brought about by infecting animals with *Schistosoma japonicum*. Of the two animals used, namely, a guinea pig and a rabbit, the latter unexpectedly died three weeks after it was exposed to the cercariæ, for which reason its serum was not tested. The guinea pig, on the other hand, survived and began passing schistosome ova in its fæces on the forty-second day after it was exposed to the parasite. When its serum was tested, the cercaricidal titer was found to be much higher than that of the serum of a normal guinea pig (Table 4).

SUMMARY

Tests were made to determine the cercaricidal property of the sera of different kinds of vertebrates against two species of larval trematodes; namely, the cercaria of *Schistosoma japonicum* and of *C. maitimensis* Tubangui, 1928. All the sera tested, except those of the cat and the rabbit, possessed marked cercaricidal action against the cercaria of *Schistosoma japonicum*. On *C. maitimensis* the effect was only partial.

The cercaricidal titers of the different sera against the cercaria of *Schistosoma japonicum* varied within appreciably wide limits. The titers of the sera of man, guinea pig, and other warm-blooded vertebrates which are known to serve as favorable hosts to the adult parasite, were found to be uniformly low, while those of the sera of cold-blooded vertebrates that are not susceptible to the parasite were much higher.

The cercaricidal (cercariolytic), bacteriolytic, hæmolytic, and other cytolytic properties of the blood are probably analogous phenomena due to the union of the corresponding antigens with

antibodies of the third order and complement. The fresh normal sera of the cat and the rabbit possess no cercaricidal property, due probably to a deficiency in both amboceptor and complement.

The cercaricidal titer of the serum of a guinea pig infected with *Schistosoma japonicum* was found to be much higher than that of the serum of a normal animal belonging to the same species, due apparently to an increase in the amboceptor content of the blood as a result of the infection.

ACKNOWLEDGMENT

We wish to acknowledge gratefully our indebtedness to Drs. S. A. Francisco and A. Dasmariñas, of the Bureau of Health, for supplying us with snails (*Schistosomophora hydrobiopsis*) infected with the cercaria of *Schistosoma japonicum;* and to Dr. Jose Ramirez, of the Bureau of Science, for titrating some of the sera used in our studies for complement.

REFERENCES CITED

CULBERTSON, J. T., and S. B. TALBOT. A new antagonistic property of normal serums: the cercaricidal action. Science n. s. 82 (1935) 525-526.

SCHÖBL, O., and C. MONSERRAT. Substitution of human blood cells by monkey's red corpuscles in performing the complement-fixation test for syphilis. Philip. Journ. Sci. § B 12 (1917) 249-257.

TUBANGUI, M. A. Larval trematodes from Philippine snails. Philip. Journ. Sci. 35 (1928) 37-64.

NOTES ON PHILIPPINE LINGUATULIDS (ARTHROPODA: PENTASTOMIDA)

By MARCOS A. TUBANGUI and VICTORIA A. MASILUÑGAN
Of the Bureau of Science, Manila

THREE TEXT FIGURES

According to Hill (1934), more than fifty species of linguatulids, or tongue worms, have been described from different parts of the world. Only two of these have been recorded from the Philippines; namely, *Armillifer moniliformis* reported by Tubangui (1924) from the reticulated python and the civet cat, and *Alofia travassosi* reported by Heymons (1932) from an unknown host (probably a crocodile) in Samar Island. Recently there were added to the parasitological collection of the Philippine Bureau of Science three representatives of this group of parasites, the identity of which is discussed below.

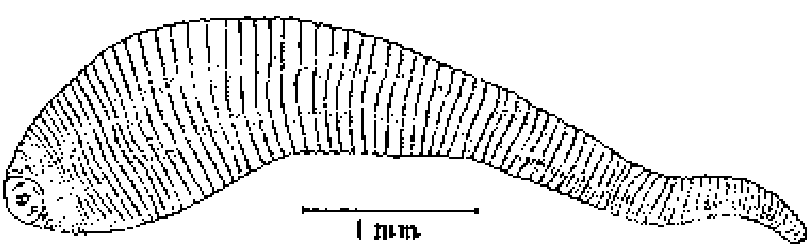

FIG. 1. *Linguatula serrata* Froelich; adult female, entire worm, ventral view.

LINGUATULA SERRATA Froelich, 1789. Text fig. 1.

A single adult female specimen of this tongue worm was received from Dr. M. V. Santiago, who states in a letter that it was coughed out by a dog in Ajuy, Iloilo. The body of the parasite is of characteristic shape, possesses about ninety abdominal segments and measures as follows: Length, 50 millimeters; width near anterior end, 9 millimeters, and at posterior end, 2 millimeters.

The adult form of this parasite has been found in man and in the dog and other carnivores in different parts of the world, and the nymphal stage has been found in man and various species of herbivorous animals.

RAILLIETIELLA AGCOI sp. nov. Text fig. 2.

This linguatulid is named for Mr. Antolin Agco, of the Fish and Game Administration Division, Bureau of Science, who collected several adult female specimens of the parasite from a cobra. Compared with the other members of the genus *Raillietiella* which have been reported from snakes in the Oriental Region, it appears to bear the closest resemblance to *R. orientalis* (Hett, 1915), a parasite of the Indian snakes *Zamenis mucosus* and *Naja tripudians*. It differs from the latter in the following respects: It is smaller and the number of its abdominal rings is less, the maximum being thirty-five. In *R. orientalis* the number of rings is forty or more.

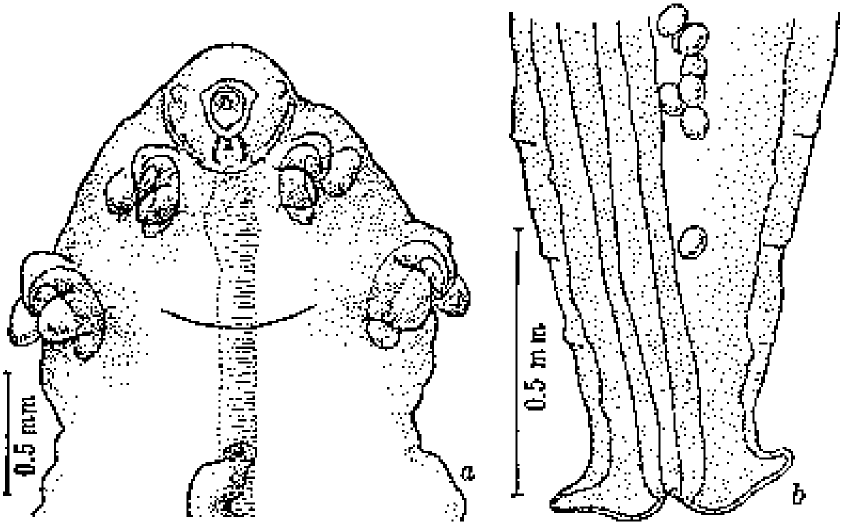

FIG. 2. *Raillietiella agcoi* sp. nov.; a, anterior end, ventral view; b, posterior end, ventral view.

Description.—Body of adult females slender, gradually tapering towards posterior end, 16 to 39 millimeters long (average length 28 millimeters). Cephalothorax more or less conical, 1.35 to 1.65 by 1.25 to 1.70 millimeters in size. Mouth ventrosubterminal, surrounded by a suckerlike prominence and provided with a distinctive oral armature representing the pharynx. Hooks unequal, arranged in trapezoidal formation, with strongly recurved distal extremities and each surrounded by three vesicular projections that are characteristic of the genus *Raillietiella*. Anterior pair of hooks smaller, 210 to 305 microns long; posterior hooks 285 to 400 microns long. Two other vesicular

projections are found on the dorsal surface of the cephalothorax on a level with the anterior pair of hooks.

Abdomen with thirty-two to thirty-five annulations; terminal segment divided into two divergent lobes, between which is the anal opening.

Uterovagina in the form of a simple sac. Genital opening median, at anterior end of abdomen, 1.25 to 1.65 millimeters from posterior border of mouth. Eggs 99 to 109 by 76.5 to 84.5 microns in size.

Host.—Cobra (*Naja naja philippinensis*).

Location.—Lungs.

Locality.—Cabanatuan, Nueva Ecija, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 473.

PENTASTOMUM SOLARIS sp. nov. Text fig. 3.

This linguatulid is represented in the collection by several immature specimens obtained from the lungs of a crocodile. It is characterized by the presence of an accessory hook on each of the two pairs of principal hooks and of minute spines on the posterior borders of the abdominal rings. According to Hett (1924), these characters represent larval features that are usually thrown off at the last ecdysis during the course of development of this group of parasites.

The parasite bears some resemblance to *Pentastomum gracile*, which, according to Sambon (1922), is probably an immature form of *Leiperia cincinnalis*. The possibility of its being a developmental stage of *Alofia travassosi* should be kept in mind in view of the suspicion of Heymons (1932) that the final host of *A. travassosi* is probably a Philippine crocodile.

Description.—Body cylindrical, rounded at both extremities, 3.5 to 21.5 millimeters in length by 0.6 to 0.8 millimeter in maximum diameter. Cephalothorax small, 0.22 to 0.54 by 0.50 to 0.75 millimeter in size. Mouth ventral, on posterior hook line, in small specimens 0.17 to 0.23 and in the largest specimen 0.44 millimeter from anterior end; oral armature horseshoe-shaped. A pair of papillæ present, one on each side of median line in front of anterior hooks. Hooks unequal, disposed archwise, each with a massive root and an accessory spine; anterior hooks 0.19 to 0.50, posterior hooks 0.20 to 0.60 millimeter long.

Abdomen distinctly annulated, with ninety to one hundred twenty rings; in some specimens lateroventral grooves or lines

are present. Each abdominal ring is provided with a circlet of very minute spines on its posterior border and numerous small openings or stigmata that are usually arranged in a single row near the center of the ring.

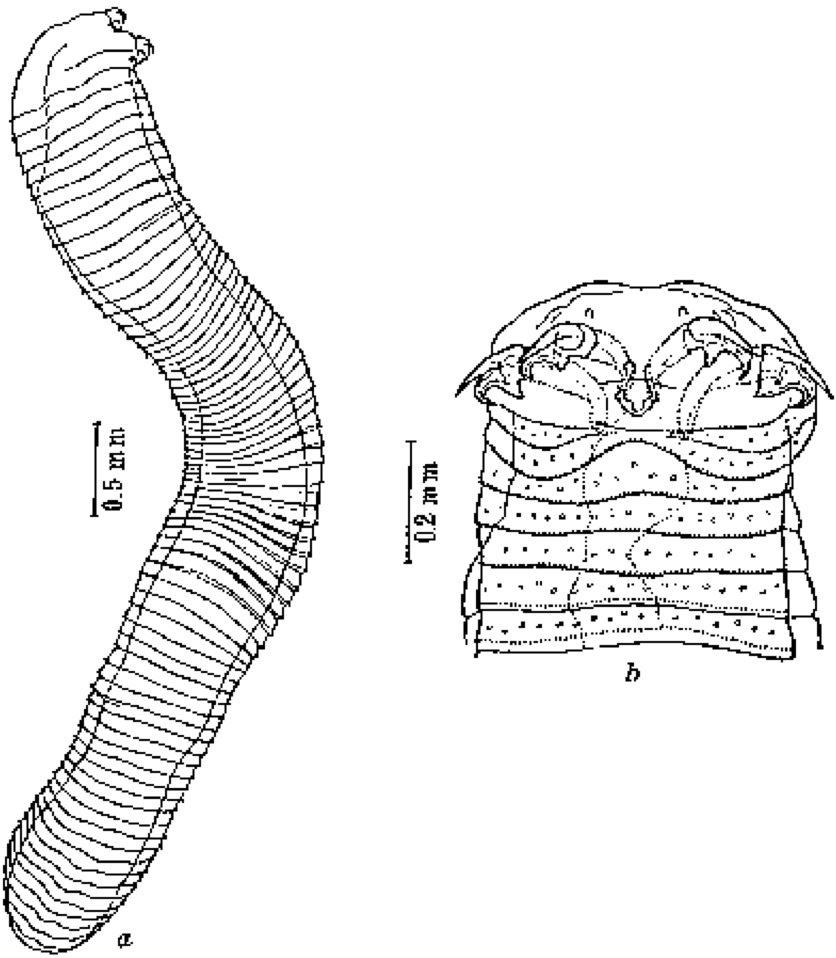

FIG. 3. *Pentastomum solaris* sp. nov., a, entire worm, lateral view; b, anterior end, ventral view.

Alimentary tract slightly sinuous; anus posteroterminal.

Host.—Crocodile (*Crocodilus porosus*).

Location.—Lungs.

Locality.—Palawan.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 476.

REFERENCES CITED

HETT, M. L. On some new pentastomids from the Zoological Society's Gardens, London. Proc. Zool. Soc. London 1 (1915) 115–121.

HETT, M. L. On the family Linguatulidae. Proc. Zool. Soc. London 1 (1924) 107–159.

HEYMONS, R. Eine neue Pentastomide von den Philippinen. Zool. Anz. 97 (1932) 295–299.

HILL, H. R. The occurrence of linguatulids in pythons. South. Calif. Acad. Sci. 33 (1934) 117–122.

SAMBON, L. W. A synopsis of the family Linguatulidae. Journ. Trop. Med. Hyg. 25 (1922) 188–206; 391–428.

TUBANGUI, M. A. Two larval parasites from the Philippine palm civet (Paradoxurus philippinensis). Philip. Journ. Sci. 24 (1924) 749–763.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Linguatula serrata* Froelich; adult female, entire worm, ventral view.

2. *Raillietiella agcoi* sp. nov.; *a*, anterior end, ventral view; *b*, posterior end, ventral view.

3. *Pentastomum solaris* sp. nov.; *a*, entire worm, lateral view; *b*, anterior end, ventral view.

A REVIEW OF PHILIPPINE PIGEONS, IV
SUBFAMILY DUCULINÆ

By CANUTO G. MANUEL

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

The nature and the scope of the present paper are similar to those of the previous numbers of this series. In this paper the subfamily Duculinæ comprises the genera *Ducula*, *Myristicivora*, *Ptilocolpa*, and *Zonophaps*. These are large Philippine Columbidæ, distinguished from other forest-inhabiting pigeons of the same size by their under tail coverts, which are slightly, if ever, longer than their toes.

Specimens in the collections of the Agricultural College and of Mr. Moises Villaluz, both in Laguna Province; of Mr. Graciano Castañeda, of Pasay, Rizal Province; and of Mr. Carlos Esperancilla, of Sagay, Occidental Negros, were examined in addition to those in the collection of the Bureau of Science. I wish to express my obligations to these persons for their coöperation. The races reported from the Archipelago but not examined in this study are enumerated but not discussed in this paper.

Key to the Philippine genera of Duculinæ.

a^1. General color of underparts white .... *Myristicivora*.
a^2. General color of underparts not white.
  b^1. Underparts except under tail coverts uniformly gray .... *Ducula*.
  b^2. Underparts not uniformly gray.
    c^1. Breast green .... *Zonophaps*.
    c^2. Breast gray and chestnut .... *Ptilocolpa*.

Genus MYRISTICIVORA Reichenbach, 1852

General color creamy white with wing quills and distal half of most tail feathers slaty black. First and second primaries slightly scooped in their inner web.

One race is known in the Philippines.

MYRISTICIVORA BICOLOR BICOLOR (Scopoli).

Columba bicolor SCOPOLI, Del. Flor. et Faun. Insubr. 2 (1786) 94.

Carpophaga casta PEALE, U. S. Explor. Exped. Mammalogy and Ornithology 8 (1848) 204.

Carpophaga bicolor CASSIN, U. S. Explor. Exped. Mammalogy and Ornithology (1858) 265, pl. 28.

Myristicivora bicolor WALDEN, Trans. Zool. Soc. London 9 pt. 2 (1875) 217.

Myristicivora bicolor bicolor HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 204.

Balabac, Bantayan, Bungau, Cresta de Gallo, Guimaras, Malanipa, Marinduque, Masbate, Mindanao, Mindoro, Negros, Nipah, Palawan, Sakuyok, Sibay, Siquijor, Sulu, Tawitawi, Ticao, and West Bolod.

Specimens from Bantayan, Mindoro, Murcielagos, Palawan, Polillo, Siquijor, and Ticao were examined.

Measurements of Myristicivora bicolor bicolor (Scopoli) based on four males and five females.

	Extremes, mm.	Mean, mm.
Wing	227–239	233.0
Tail	127–135	130.6
Culmen	22–23	22.33
Tarsus	30–32	31.33
Middle toe with claw	44–46	44.4

The material studied from widely separated islands shows uniformity indicating the existence of only one race in the Philippines. According to Hachisuka (1932) the Philippines represents the northeastern range of this subspecies. Chasen (1935) records its occurrence in several islands of Malaysia.

Genus DUCULA Hodgson, 1836

General color of upper parts, except head and neck, largely metallic bluish green; head, neck, and underparts pearly gray or pale vinaceous fawn. Inner web of first primary slightly attenuated.

McGregor and Worcester (1906) recorded six species for the Philippines. Two species with seven subspecies were recorded by Hachisuka (1932).

In this paper the genus is treated with two species grouped into eight subspecies. *D. a. glaucocauda* is described as a new race.

Key to Philippine species of Ducula.

a^1. Upper parts metallic bluish green, under tail coverts chestnut.... *ænea.*
a^2. Upper parts metallic bluish gray, under tail coverts gray.... *pickeringii.*

DUCULA ÆNEA ÆNEA (Linnæus).

Carpophaga ænea GUILLEMARD, Proc. Zool. Soc. London (1885) 270.

Muscadivora ænea MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Ducula ænea ænea HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 194.

Bungau, Sulu, and Tawitawi.

No specimen has been examined in this study.

DUCULA ÆNEA CHALYBURA (Bonaparte).

Carpophaga chalybura BONAPARTE, Consp. Gen. Avium 2 (1854) 32.

Carpophaga ænea WALDEN, Trans. Zool. Soc. London 9 pt. 2 (1875) 215.

Carpophaga nuchalis CABANIS, Journ. für Orn. (1882) 126.

Muscadivora ænea MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivora nuchalis MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivores chalybura MCGREGOR, Manual Philippine Birds pt. 1 (1909) 43.

Muscadivores ænea chalybura HACHISUKA, Contrib. Birds Philippines No. 2 (1930) 140.

Ducula ænea chalybura HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 194.

Bantayan, Basilan, Bohol, Camiguin N., Calayan, Catanduanes, Cebu, Dinagat, Fuga, Guimaras, Lubang, Luzon, Marinduque, Mindanao, Mindoro, Negros, Panay, Samar, Semirara, Sibuyan, Siquijor, Tablas, and Ticao.

Specimens from Bantayan, Basilan, Bohol, Camiguin N., Calayan, Cebu, Fuga, Luzon, Mindanao, Mindoro, Negros, Panay, Polillo, Samar, Siquijor, Tablas, and Ticao were examined.

Measurements of Ducula ænea chalybura (Bonaparte) based on twenty-four specimens of each sex.

	Extremes, mm.	Mean, mm.
Wing	232–250	238.52
Tail	143–158	150.31
Culmen	20–22	20.77
Tarsus	32–34	32.71
Middle toe with claw	46–50	48.63

Cabanis (1882) described *Carpophaga* (= *Ducula*) *nuchalis* on the basis of the cupreous chestnut nape of specimens from Luzon. Hachisuka (1932) considers this character of a seasonal nature and regards *nuchalis* as a synonym of *chalybura*. Among nineteen specimens in the collections of the Bureau of Science, of the College of Agriculture, University of the Philippines, and of Moises Villaluz from Luzon, seven birds obtained north of 16° north are distinctly chestnut-naped, while eleven of twelve from south of this latitude are distinct in the absence of that character (Plate 1). These birds were all collected in April, May, and June. This shows that cause for this difference is not of a seasonal nature. With respect to this particular char-

acter the birds from southern Luzon (south of 16° north) resemble those from Mindoro and Polillo. On the other hand, specimens from Samar and Mindanao may, on the basis of this character, be separated from those already mentioned on the basis of a faint trace of chestnut on the nape. The lone specimen from Camarines Sur Province (southern Luzon), however, resembles those from Samar in this character. Until more specimens have been studied, this group of pigeons from Luzon will be regarded as one race.

The sheen on the back, which may be bluish green or brown, is a variable character possessed by specimens from the same locality obtained at the same time.

Only one specimen from Basilan was examined in this study. Its tail measures 143 mm, while 148 mm is the minimum tail length of *D. a. chalybura* from other regions. When sufficient specimens (*Ducula ænea*) are studied from this island, they may be found to belong to the typical race.

DUCULA ÆNEA FUGAENSIS Hachisuka.

Carpophaga anchalis OGILVIE-GRANT, Ibis VII 2 (1896) 124.

Muscadivora anchalis MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivores ænea fugaensis HACHISUKA, Contrib. Birds Philippines No. 2 (1930) 150.

Ducula ænea fugaensis HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 196.

Ogilvie-Grant (1896) suspected the male bird that Whitehead collected from Fuga to be a distinct subspecies. Hachisuka (1930) named the lone bird in the collection of the Bureau of Science that was collected by McGregor on Fuga as *Muscadivores ænea fugaensis*. He used its size as the distinguishing criterion, contending that the wing of this bird is 20 mm longer than that of *M. a. chalybura*. Specimens from Calayan and Camiguin in the collection of the Bureau of Science are, in general, larger than *D. a. chalybura* from Luzon as shown in Table 1.

DUCULA ÆNEA GLAUCOCAUDA subsp. nov.

Carpophaga ænea TWEEDDALE, Proc. Zool. Soc. (1879) 832.

Muscadivora ænea MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivores chalybura MCGREGOR, Manual Philippine Birds, pt. 1 (1909) 43.

Ducula ænea chalybura HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 194.

TABLE I.—*Measurements of D. ænea from the Babuyan group.*

Island.	Catalogue No. and sex.	Wing.	Tail.	Culmen.	Tarsus.	Middle toe and claw.
		mm.	mm.	mm.	mm.	mm.
Calayan	3244 ♂	248	149	23	34	49
Do	3245 ♀	256	156	23	34	51
Do	3059 ♂	253	158	22	34	49
Camiguin	6049 ♂	236	156	22	34	46
Fuga	3038[1] ♂	265	154	21	35	49

[1] Type of *D. a. fugaensis* Hachisuka.

Six specimens from Samar are similar to one from Biliran and seven from Mindanao (Cotabato, Davao, and Surigao). They are, however, distinct from the other birds studied.

Subspecific characters.—Resembling *Ducula ænea chalybura* of southern Luzon, Mindoro, Polillo, Bantayan, Cebu, Bohol, Basilan, Negros, Panay, Siquijor, Tablas, and Ticao, but with upper surface of rectrices appearing as if covered with a fine gray powder. This substance is also distinctly manifest on the upper surface of primaries and secondaries.

Description.—Type, adult male, Bureau of Science collection, No. 29448; Mount Matutum (altitude about 600 meters), Cotabato, Mindanao, April 11, 1932; Francisco Rivera. Edge of forehead creamy white, rest of forehead, crown, occiput and anterior nape pale vinaceous-fawn, rest of nape with trace of light vinaceous-fawn, foreneck pale vinaceous-fawn gradually blending into pale olive-gray of hind neck. Back (dorsum, notæum), wing coverts, and rump metallic bluish green when held towards the light, against a vertical light this color turns to metallic reddish brown. Exposed surface of primaries and secondaries, upper tail coverts and upper surface of rectrices castor gray with an apparent coating of a dawn gray powdery substance that turns to shades between blue and green, depending on its position with regard to the light; sides of head pale vinaceous-fawn; orbital ring creamy white; chin creamy white gradually changing to pale vinaceous-fawn of throat and rest of underparts except thighs which are mineral gray, under tail coverts bay, under surface of rectrices brownish olive with golden sheen.

Measurements of the type.—Wing, 234 mm; tail, 140; culmen, 21; tarsus, 32; middle toe with claw, 44.

In the collection of the Bureau of Science the specimens of this race of imperial fruit pigeon are as follows:

Measurements of Ducula ænea glaucocauda subsp. nov.

Bureau of Science No.	Sex.	Locality.	Date.	Collector.
29501	♀	Wright, Samar	May 28, 1924	R. C. McGregor et al.
29502	♀	do	May 30, 1924	Do.
29503	♀	do	May 31, 1924	Do.
29504	♀	do	June 1, 1924	Do.
29505	♂	do	June 9, 1924	Do.
29506	♂	do	June 14, 1924	Do.
12355	♀	Butuan, Agusan	Dec. 27, 1907	A. Celestino.
8131	♀	Davao (Mount Galintan)	May 9, 1927	F. Rivera.
29178	♀	Mainit, Surigao	Mar. 17, 1931	A. C. Duyag.
29447	♀	Nupal, Cotabato	Mar. 9, 1932	F. Rivera.
29458	♂	Mount Malutum, Cotabato (type)	Apr. 11, 1932	Do.
29252	♂	do	Apr. 12, 1932	Do.
29459	♂	do	Apr. 12, 1932	Do.
7240	♀	Dilisan	May 25, 1914	R. C. McGregor and A. Celestino.

Remarks.—All previous workers regarded this bird as *Ducula ænea chalybura.*

DUCULA ÆNEA PALAWANENSIS (Blasius)

Carpophaga ænea TWEEDDALE, Proc. Zool. Soc. London (1878) 623.

Carpophaga ænea palawanensis BLASIUS, Ornis 4 No. 2 (1888) 316.

Muscadivora ænea MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivores æneus palawanensis OBERHOLSER, U. S. Nat. Mus. Bull. 159 (1932) 27.

Ducula ænea palawanensis HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 195.

Balabac, Calamianes, and Palawan.

Specimens from Balabac, Culion, Linapacan, and Palawan were examined.

Measurements of Ducula ænea palawanensis (Blasius) based on seven males and nine females.

	Extremes. mm.	Mean. mm.
Wing	243–262	248.75
Tail	155–171	163.45
Culmen	20–22	21.06
Tarsus	32–33	32.44
Middle toe with claw	44–48	45.84

This race is distinguished from the other Philippine pigeons of the species *D. ænea* by its deeper glossy bluish green (dusky dull green) on upper surface of rectrices. Generally, the wings

and tail are longer than in other forms, excepting those from Siquijor and Fuga, and some from Calayan and Camiguin. Hachisuka (1932) regards Mindoro, Polillo, and Tablas as ranges for the present race. *D. ænea chalybura* is also considered by him as inhabiting these islands. After an examination of eleven birds from Mindoro, two from Tablas, and two from Polillo, I am convinced that the birds from these islands belong to *D. ænea chalybura*.

DUCULA PICKERINGII PICKERINGII (Cassin).

Carpophaga pickeringii CASSIN, U. S. Explor. Exped. Ornithology (1852) 267.

Muscadivora pickeringii MCGREGOR and WORCESTER, Hand-List Birds Philippine Islands (1906) 11.

Muscadivores pickeringii pickeringii RILEY, Proc. U. S. Nat. Mus. 77 Art. 12 (1930) 7.

Ducula cineracea pickeringii HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 197.

Cagayancillo, Cagayan Sulu, Sibutu, and Sulu.

Specimens from Balabac, Cagayancillo, Cagayan Sulu, Calusa, Cavillé, Lumbucan, and Ursula were examined.

Measurements of twelve males and ten females (2 not sexed) are as follows:

Measurements of Ducula pickeringii pickeringii (Cassin).

	Extremes, mm.	Mean, mm.
Wing	224–241	231.15
Tail	152–175	156.21
Culmen	18–19	18.71
Tarsus	32–34	33.45
Middle toe with claw	40–44	41.88

This race is distinguished by the creamy white frontal edge of forehead and chin and narrow ring of feathers around eye; head and underparts pale vinaceous-fawn, this color gradually changing into gray of head, neck, and mantle; back, including wing coverts, deep mouse gray with a greenish brown tinge; wings dark gray with green tinge on exposed areas; upper surface of tail metallic green, undersurface gray.

DUCULA PICKERINGII LANGHORNEI (Mearns).

Muscadivora langhornei MEARNS, Proc. Biol. Soc. Wash. 18 (1905) 84.

Muscadivores pickeringii langhornei RILEY, Proc. U. S. Nat. Mus. 77 Art. 12 (1930) 7.

Ducula cineracea langhornei HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 197.

Bolod.

No bird of this race has been examined.

DUCULA PICKERINGII PALMASENSIS (Mearns).

Muscadivores palmasensis MEARNS, Proc. U. S. Nat. Mus. 36 (1909) 436.

Muscadivores pickeringii palmasensis RILEY, Proc. U. S. Nat. Mus. 77 Art. 12 (1930) 7.

Ducula cineracea palmasensis HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 198.

Palmas Island in Celebes Sea.

No specimen was examined in this study.

Genus PTILOCOLPA Bonaparte, 1854

First primary attenuated and greatly scooped on middle of its inner web; sexes dissimilarly colored but shade of chestnut dominant in under parts of both.

A monotypic genus confined in the Philippines. Three races are known.

PTILOCOLPA CAROLA CAROLA (Bonaparte).

Carpophaga carola BONAPARTE, Consp. Gen. Avium 2 (1854) 34.

Ptilocolpa carola BONAPARTE, Consp. Gen. Avium 2 (1854) 34.

Ptilocolpa griseopectus WALDEN, Trans. Zool. Soc. London 9 pt. 2 (1875) 216.

Ptilocolpa carola carola HACHISUKA, Contrib. Birds Philippines No. 2 (1930) 151.

Luzon, Mindoro, and Sibuyan.

Specimens from these islands were examined.

Measurements of Ptilocolpa carola carola Bonaparte based on ten males and fifteen females.

	Extremes. mm.	Mean. mm.
Wing	210–221	214.36
Tail	122–136	126.25
Culmen	17–18	17.2
Tarsus	26–27	26.04
Middle toe with claw	40–43	41.13

Male.—Head, nape, back, and interscapular light gull gray; chin creamy white gradually changing to pale gull gray band of throat. Band bordered posteriorly by a white line which forms the anterior border and the arc of a gray semilunar pectoral area. Lower breast, abdomen, and under tail coverts chestnut; flanks gray with impressions of chestnut on their lower border. Except the outer pair, which are yellowish brown with white shafts, the undersurface of the rectrices are black. Wing quills gray with green gloss. Coverts gray, many feathers with a dark spot at tip; rump glossy green with brown mottles; upper tail coverts and upper surface of rectrices glossy bluish green.

Female.—Differs from the male in having a plumbeous head and neck; interscapulars mottled with plumbeous and green glossed with metallic copper red; rest of back with more green impressions; no band on underparts; chestnut lighter.

PTILOCOLPA CAROLA NIGRORUM Whitehead.

Ptilocolpa nigrorum WHITEHEAD, Bull. Brit. Orn. Club 6 (1897) 34.

Ptilocolpa carola nigrorum HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 203.

Negros.

I have not examined birds from this locality.

PTILOCOLPA CAROLA MINDANENSIS Ogilvie-Grant.

Ptilocolpa mindanensis OGILVIE-GRANT, Bull. Brit. Orn. Club 16 (1905) 16.

Ptilocolpa carola mindanensis HACHISUKA, Birds Philippine Islands pt. 2 (1932) 203.

Mindanao.

Six birds from this island (Agusan and Davao Provinces) were examined.

Measurements of Ptilocolpa carola mindanensis Ogilvie-Grant based on two males and four females.

	Extremes. mm.	Mean. mm.
Wing	192–208	197.40
Tail	116–125	119.50
Culmen	16–17	16.60
Tarsus		26.00
Middle toe with claw	37–40	38.00

Resembles closely *P. carola carola*, but male has chin and throat white and pectoral area grayish black.

Genus ZONOPHAPS Salvadori, 1893

Large; bare circumocular area distinct; first and second primaries scooped near middle of their inner webs; tail crossed by a gray band near tip.

Two species and three races were recorded by Hachisuka (1932) in the Philippines.

ZONOPHAPS POLIOCEPHALA POLIOCEPHALA (Gray).

Carpophaga poliocephala GRAY, List Birds Brit. Mus. pt. 3 (Gallinae) (1844) 6.

Hemiphaga poliocephala WALDEN, Trans. Zool. Soc. London 9 pt. 2 (1875) 217.

Carpophaga (Zonophaps) poliocephala SALVADORI, Cat. Birds Brit. Mus. 21 (1893) 207.

Zonophaps poliocephala SHARPE, Hand-List Birds 1 (1899) 65.

Zonophaps poliocephala poliocephala HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 199.

Cebu, Leyte, Luzon, Mindoro, and Panay.

Specimens from Luzon and Mindoro were examined.

Measurements of two females from Luzon are as follows: Wing, 222 mm, 225; tail, 160, 160; culmen 20, 19; tarsus, 26, 28; middle toe and claw, 47, 47.

Hachisuka's *poliocephala* does not have a purplish brown sheen on the back. The birds from Mindoro, according to these two birds from Luzon, should, therefore, be excluded from this race.

ZONOPHAPS POLIOCEPHALA NOBILIS Hachisuka.

Hemiphaga poliocephala SHARPE, Trans. Linn. Soc. London 2d ser. 1 Zoölogy (1875) 347.

Zonophaps poliocephala SHARPE, Hand-List Birds 1 (1899) 65.

Zonophaps poliocephala nobilis HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 200.

Basilan, Dinagat, Masbate, Mindanao, Negros, Samar, Sibuyan, and Tawitawi.

Specimens from Basilan, Mindanao, Negros, and Sibuyan were examined.

Measurements of Zonophaps poliocephala nobilis Hachisuka based on three males and ten females

	Extremes. mm.	Mean. mm.
Wing	217–228	222.23
Tail	155–163	160.10
Culmen	19–22	20.27
Tarsus	27–31	27.90
Middle toe with claw	46–48	47.07

The birds from Mindoro should belong to this race which is distinguished from the typical race by the purplish brown sheen on the back.

ZONOPHAPS MINDORENSIS (Whitehead).

Carpophaga mindorensis WHITEHEAD, Ann. & Mag. Nat. Hist. VI 18 (1896) 189.

Zonophaps mindorensis SHARPE, Hand-List Birds 1 (1899) 65.

Mindoro.

I have not examined this species.

LITERATURE CITED

BLASIUS, W. Die Vögel von Palawan. Ornis 4 No. 2 (1888) 316.

BONAPARTE, CHARLES-LUCIEN. Consp. Gen. Avium 2 (1854) 32.

CABANIS, J. Journ. für Orn. (1882) 126.

CASSIN, J. United States Explor. Exped. Ornithology (1858) 265, 267. pl. 26.

CHASEN, F. N. Hand-List of Malaysian Birds. Bull. Raffles Mus. No. 11 (1935) 10.

GRAY, G. R. Birds Brit. Mus. pt. 3 (Gallinae) (1844) 6.

GUILLEMARD, F. H. H. Report on the collections of birds made during the voyage of the yacht Marchesa.—I. A provisional list of the birds inhabiting the Sulu Archipelago. Proc. Zool. Soc. London (1885) 270.

HACHISUKA, MASAUJI. Contributions to the birds of the Philippines No. 2 (1930) 145–147.

HACHISUKA, MASAUJI. Birds of the Philippine Islands 1 pt. 2 (1932) 194–204.

MCGREGOR, R. C. Manual of Philippine Birds pt. 1 (1909) 43.

MCGREGOR, R. C., and D. C. WORCESTER. Hand-List of Birds Philippine Islands (1906) 11.

MEARNS, E. A. Descriptions of eight new Philippine birds, with notes on other species new to the Islands. Proc. Biol. Soc. Washington 18 (1905) 84.

MEARNS, E. A. Additions to the list of Philippine birds, with descriptions of new and rare species. Proc. U. S. Nat. Mus. 36 (1909) 436.

OBERHOLSER, H. C. The birds of the Natuna Islands. U. S. Nat. Mus. Bull. 159 (1932) 27.

OGILVIE-GRANT, W. R. On the birds of the Philippine Islands. Part VI. The vicinity of Cape Engaño, N. E. Luzon, Manila Bay and Fuga Island, Babuyan Group. Ibis VII 2 (1896) 124.

OGILVIE-GRANT, W. R. Description of six new species of birds which had been procured by Mr. Walter Goodfellow in south-east Mindanao. Bull. Brit. Orn. Club 16 (1905) 16.

PEALE, T. R. United States Explor. Exped. 8 Mammalogy and Ornithology (1848) 204.

RILEY, J. H. Birds from the small islands off the northeast coast of Dutch Borneo. Proc. U. S. Nat. Mus. 77 Art. 12 (1930) 7.

SALVADORI, R. Cat. Birds Brit. Mus. 21 (1893) 207.

SCOPOLI, J. A. Del. Flor. & Faun. Insubr. 2 (1786) 94.

SHARPE, R. BOWDLER. On the birds collected by Prof. J. B. Steere in the Philippine Archipelago. Trans. Linn. Soc. London II 1 Zoölogy (1877) 347.

SHARPE, R. BOWDLER. A hand-list of the genera and species of birds 1 (1899) 65.

TWEEDDALE, ARTHUR, Marquis of. Contributions to the Ornithology of the Philippines. No. 3. On the collection made by Mr. A. H. Everett in the island of Mindanao. Proc. Zool. Soc. London (1877) 832.

TWEEDDALE, ARTHUR, Marquis of. Contributions to the ornithology of the Philippines. No. 9. On the collection made by Mr. A. H. Everett in the Island of Palawan. Proc. Zool. Soc. London (1878) 623.

WALDEN, ARTHUR, Viscount. A list of birds known to inhabit the Philippine Archipelago. Trans. Zool. Soc. London 9 pt. 2 (1875) 215, 217.

WHITEHEAD, J. Description of a new species of fruit-pigeon from the highlands of Mindoro, Philippine Islands. Ann. & Mag. Nat. Hist. II 18 (1896) 189.

WHITEHEAD, J. Description of a new fruit-pigeon from the highlands of Negros. Bull. Brit. Orn. Club 6 (1897) 24.

ILLUSTRATION

PLATE 1

Ducula ænea chalybura of northern and southern Luzon showing color difference of the nape.

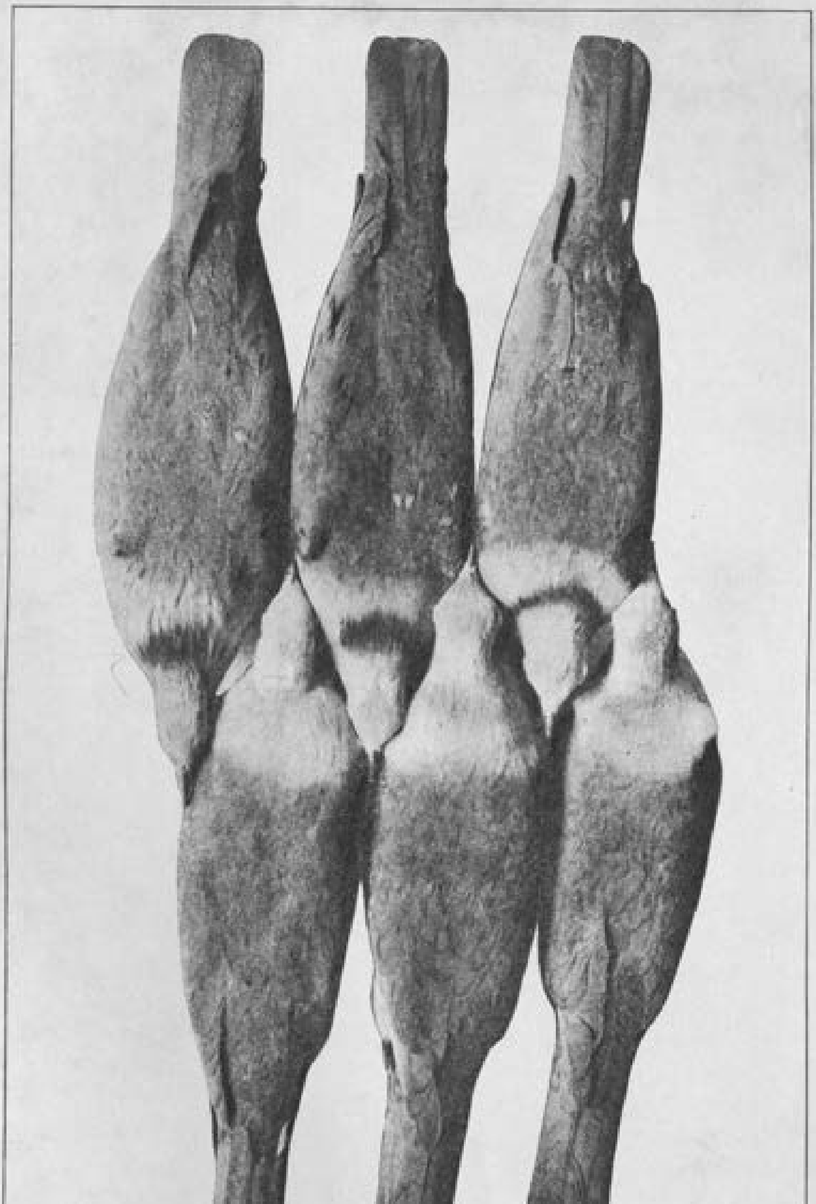

PLATE 1.

NEW OR INTERESTING PHILIPPINE SHELLS

By GODOFREDO L. ALCASID

Of the National Museum Division, Bureau of Science, Manila

FOUR PLATES

This paper deals with some new or interesting Philippine shells and contains descriptions and figures of three species of shells which have been previously described from extra-Philippine material, but are now reported for the first time in the Philippines. It also records an interesting species recently added to the Bureau of Science collection, previously described but not given any definite Philippine locality. Whenever possible original description, type locality, and distribution will be given.

The writer wishes to acknowledge with thanks the valuable suggestions and assistance given by Mr. Florencio Talavera, of the Fish and Game Administration, Bureau of Science, and to thank Mr. Gregorio A. Lopez for his unfailing enthusiasm in collecting and giving the author whatever interesting material he may encounter.

To the list of references on Philippine shells, the following may be added:

28*b*.[1] H. C. Fulton, in the Proceedings of the Malacological Society 22 (1936) 9, described a new species of *Conus* from Mindoro.

32*c*. In the second series of Pilsbry's Manual of Conchology, there appeared descriptions of several Philippine land shells. Four species of the genus *Strobilops* were given in part 110, pp. 52–56; one species of *Gastrocopta* in part III, p. 120; a list of Philippine Pupillidæ, p. 156.

35*a*. One of the Occasional Papers of the Boston Society of Natural History is Some new land mollusks from Borneo and the Philippines, by William J. Clench and Allen F. Archer 8 (1932) 37–42, pl. 4.

[1] Numbers are those used in the introduction to Bureau of Science Monograph 25; Summary of Philippine land shells, Philip. Journ. Sci. 42 (1930) 85–198; Philippine shells I, Philip. Journ. Sci. 49 (1932) 543–549.

38. In the Nautilus the following papers on Philippine shells were published:

Smith, Maxwell, New Philippine land shells 46 (1932) 62.

McGinty, Thomas L., A new Mindoro land shell 46 (1932) 65; A new Helicostyla from the Philippine Islands 48 (1934) 68.

Goodrich, Calvin, Notes on Philippine fresh-water mollusks 49 (1936) 73.

Family PERNIDÆ Zittel

Genus PEDALION Solander

(*Perna* Bruguière)

PEDALION CUMINGII (Reeve). Plate 1, figs. 1 and 2.

Perna cumingii REEVE, Conchol. Icon. 11 (1859) *Perna* pl. 1, fig. 3.

Pern. testa suborbiculari, latere antico basali producto, crassiusculâ, concentricè, rudè laminatâ, radiatim sulcatâ, laminis subfimbriatis; violaceopurpureô, fusco tinctâ.

Shell somewhat orbicular, basal anterior side produced, rather thick, concentrically rudely laminated, radiately grooved, laminæ slightly frilled; violet-purple, tinged with brown. Habitat.—Australia, *Cuming*.

The basal anterior side of this shell is but very slightly produced and straight, and maintains almost a right angle with the hinge line. The surface is concentrically rudely laminated, the laminæ regularly serrated, producing a frilled appearance and also giving a radiately grooved effect. Violet-purple, tinged with brown with the interior a dark chesnut-brown at the borders, and the middle pearly, brownish purple, iridescent. The muscle scar distinct and central.

This species very closely resembles *P. ephippium* (Linnæus), Plate 1, figs. 3 and 4, but may be distinguished from it by the nearly straight anterior end with the shell generally thinner and the internal coloration very much darker.

Locality.—LUZON, Manila breakwater, *Bur. Sci. 14655 Alcasid*. Attached to rocks and piles by means of a strong byssus.

Family OSTREIDÆ Lamarck

Genus OSTREA Linnæus

OSTREA GLOMERATA Gould. Plates 2 and 3.

Ostræa glomerata Gould, REEVE, Conchol. Icon. 18 (1873) *Ostræa* pl. 22, figs. 52*a*, *b*, *c*, *d*.

Ost. testâ crassâ, irregulari, acuticostatâ, margine dentato vel lobato, valdè inæquivalvi, valva superiori operculari, compressâ, laminis crassis concentricis rugatâ; valva inferiori cucullata, purpureâ, intùs albidâ, purpureo aut nigro marginatâ; marginibus lateribus denticulatis, cardine plerumque attenuato, producto, acuminato.

Shell thick, irregular, sharp-ribbed, with the margin dentated or lobed, very inequivalve; upper valve opercular, compressed, wrinkled with thick concentric laminæ; lower valve cucullated, purple, white within edged with purple or black; lateral margins denticulated; hinge generally attenuated, produced, pointed.

My specimens are probably immature since they are not very thick and sharp-ribbed. The shells are very inequivalved, the lower valve being deep and cup-shaped, and extending far beyond the flat opercular upper valve. The lateral margins of both valves are denticulated to about two-thirds of the entire length from the hinge. Deep purple without, whitish within and edged with purple or black; the upper valve generally grayish within.

The very young spat of this species are spinose, as in Plate 3, and may be confused with *O. spinosa;* but, as can be seen on subsequent growth, the portion of the mantle that produces the tubular spines later on produces flat foliaceous scales which give it a concentric laminated appearance.

This species was described and reported in the Conchologia Iconica without locality, supposed to have been collected by the Wilkes Expedition.

Locality.—ALABAT, Tayabas Province, *Bur. Sci. 14708 Talavera.* MINDORO, Puerto Galera, *Bur. Sci. 14659 Alcasid.* Attached in clusters to mangroove roots.

Family DOLIIDÆ Adams

Genus PYRULA Lamarck

(*Ficula* Swainson)

PYRULA DUSSUMIERI Valenciennes. Plate 4, figs. 1 and 2.

Pyrula dussumieri Val., KIENER, Iconographie des Coquiles Vivientes, Famille des Canaliferes 2, p. 25, pl. 11; TRYON, Man. Conchol. 7 (1885) 266, pl. 5, fig. 30.

Ficula dussumieri Val., REEVE, Conchol. Icon. 4 (1847) *Ficula* pl. 1, fig. 2; SOWERBY, Thes. Conchyl. 4 (1880) 110 *Ficula* pl. 423, fig. 5.

Fic. testâ elongato-pyriformi, gracili, spirâ subexsertâ, liris transversis planodepressis undique cingulatâ, lirarum interstitiis striis longitudinalibus cancellatis; pallidè spadiceâ, strigis rufofuscescentibus undulatis longitudinaliter pictâ, aperturæ fauce spadiceo-fuscescente.

Shell elongately pyriform, slender, with the spire little exserted, encircled throughout with flatly depressed transverse ridges, the interstices between which are cancellated with longitudinal striæ; pale fawn colour, painted longitudinally with waved light rufous brown streaks, interior of the aperture fawn brown.

Habitat.—China, *Cuming*.

This species is chiefly distinguished from its nearest ally, *P. reticulata* Lamarck by its more elongated and slender form together with its longitudinal wavy brown stripes.

Typically an inhabitant of the China Sea and apparently limited to this region.

Locality.—LUZON, Manila Bay, *Bur. Sci. 14660 Lopez.* Collected with beam-trawl nets in water about 40 to 50 feet deep.

Family HYDATINIDÆ Pilsbry

Genus HYDATINA Schumacher

HYDATINA ALBO-CINCTA van der Hoeven. Plate 4, figs. 3 and 4.

Hydatina albo-cincta van der Hoeven, REEVE, Conchol. Icon 16 (1868) *Hydatina* pl. 2, figs. 3*a*, *b*, *c*; ANGAS, Proc. Zool. Soc. (1877) 189; TRYON, Man. Conchol. 15 (1893) 388, pl. 45, figs. 29, 30; IWAKAWA, Cat. Jap. Moll. (1919) 168; FAUSTINO, Bur. Sci. Monog. 25 (1928) 348.

Bulla albo-cincta van der Hoeven, SOWERBY, Thes. Conchyl. 2 (1850) 566, pl. 120, figs. 17, 18.

Bulla ferruginosa PERRY, Conchology (1811) pl. 40, fig. 2.

Hyd. testâ subglobosâ, inflatâ tenui, semipellucidâ, fusco-cinerascente, fasciis tribus latis albis radiatâ et striis obliquis, fuscis, numerosis, longitudinalibus pictâ, spirâ retusa, concavâ, aperturâ anticè amplissimâ.

Shell subglobose, inflated, thin, semipellucid, brownish ash-coloured, rayed with three broad white bands, and painted with oblique, brown, numerous, longitudinal striæ, spire retuse, concave; aperture very wide in front.

Habitat.—China, *Cuming*.

The spire of this species is concave; the shell very delicate, covered with a thin, semipellucid, ash-colored epidermis which is finely and obliquely streaked with brown, the streaks interrupted by five sharply defined white bands. Interior white, aperture broadly rounded anteriorly.

Distribution.—China, *Cuming;* Philippines, *Jay;* Japan, *Iwakawa;* Port Stephens, New South Wales, Australia, *Brazzier.*

Locality.—LUZON, Manila Bay, *Bur. Sci. 14661 Lopez.* Collected with beam-trawl nets in water about 40 to 50 feet deep.

ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Pedalion cumingii* Reeve.
3 and 4. *Pedalion ephippium* (Linnæus).

PLATE 2

FIGS. 1 to 5. *Ostrea glomerata* Gould.

PLATE 3

FIGS. 1 and 2. *Ostrea glomerata* Gould, spat. These are the shells shown in Plate 2, figs. 4 and 5, enlarged to show tubular spines.

PLATE 4

FIGS. 1 and 2. *Pyrula dussumieri* Valenciennes.
3 and 4. *Hydatina albo-cincta* van der Hoeven.

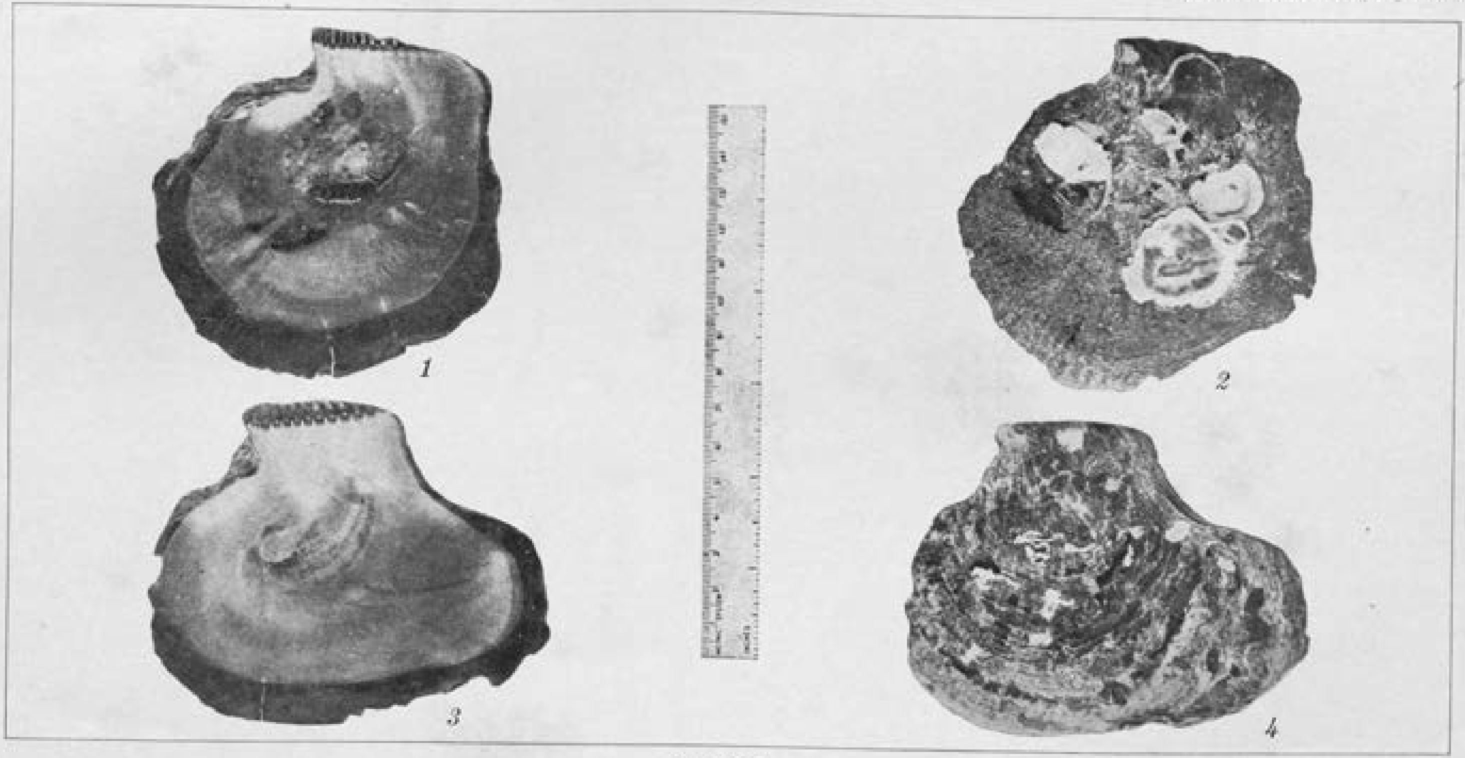

PLATE 1.

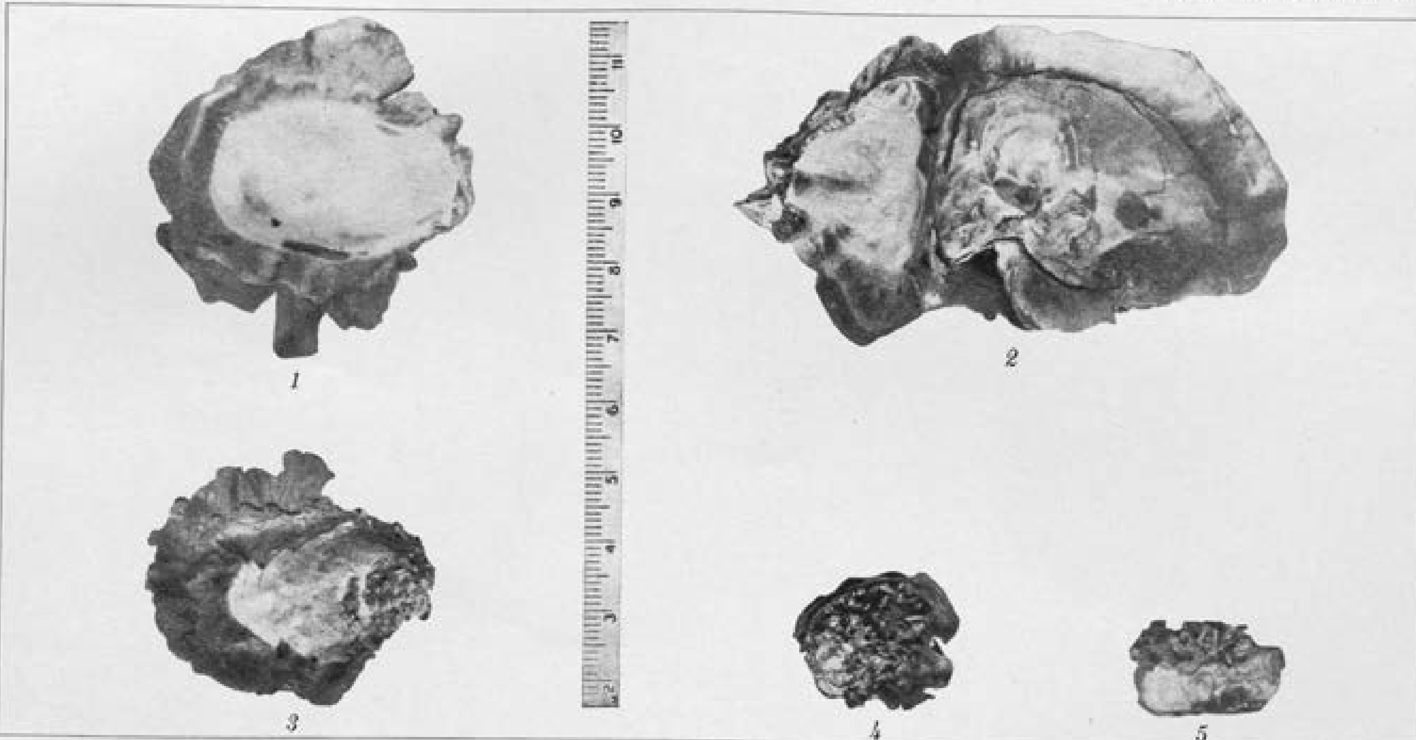

PLATE 2.

PLATE 3.

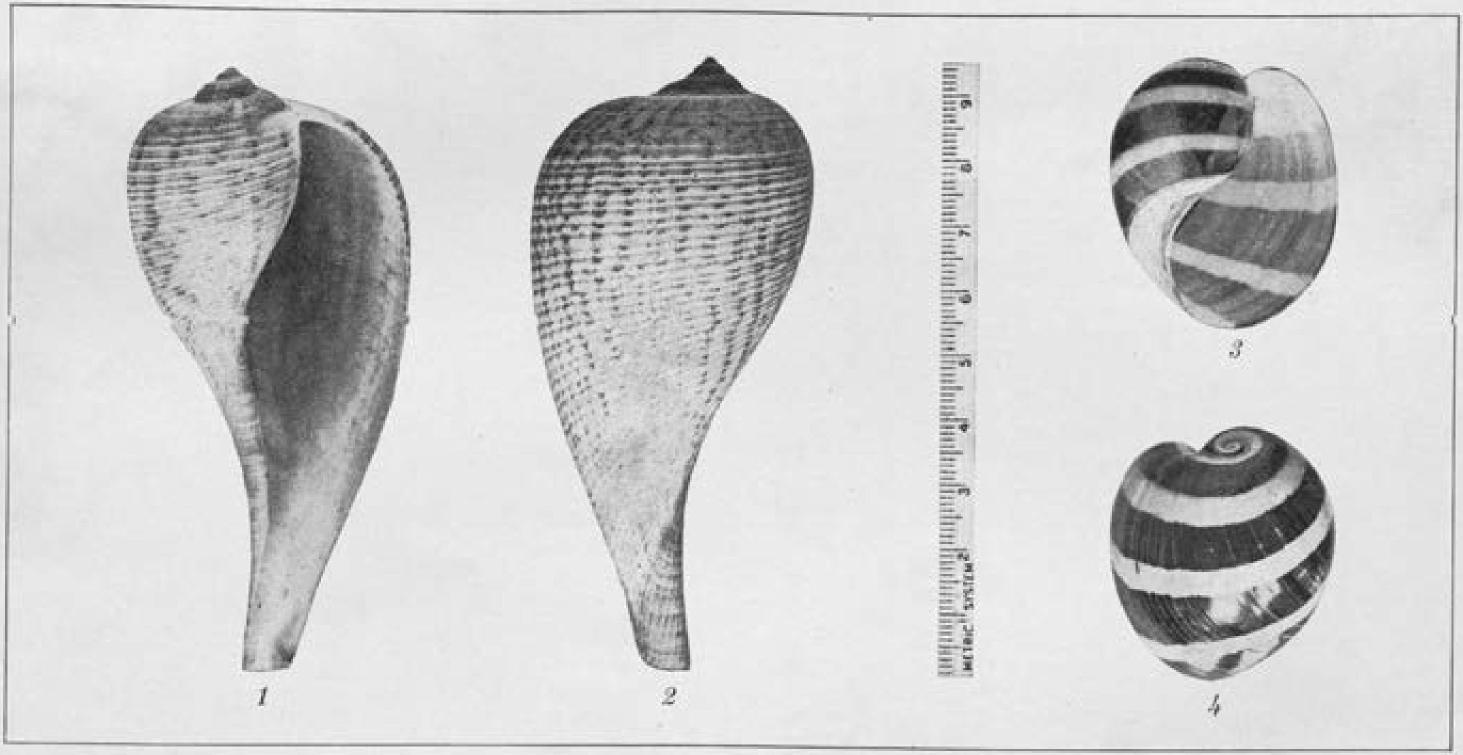

PLATE 4.

THYSANOPTERA OF FORMOSA

By Ryoichi Takahashi

Of the Department of Agriculture, Research Institute, Formosa

FOUR TEXT FIGURES

About fifteen years ago I became much interested in the Thysanoptera of Formosa. Since that time I have given my attention to these insects as opportunity permitted, and the results of my observations on the metamorphosis, biology, and economic status of some species have been published.[1] I have scarcely been able, however, to find time for the systematic study of the group, and many of my specimens have been sent for identification to specialists of this group in this country and abroad, and many species have been recorded from my collections by D. Moulton, H. Priesner, and others.

I am convinced that the thrips fauna of the island is fairly well known, and in the present paper an attempt has been made to list all the species now known to occur in the island, with brief biological notes on some of them. Two new species and one new variety are here described.

In this paper ninety-nine species and three varieties are enumerated, which include some that are hitherto unrecorded from Formosa. There are a few species in my collection not yet identified, which are not dealt with here. The food plants given in the following pages are records for Formosa alone.

I am especially indebted to Dr. H. Priesner and Prof. J. D. Hood for their valuable help in determining my specimens, and also to Prof. T. Shiraki for his kind help in various ways.

TEREBRANTIA

THRIPIDÆ

HELIOTHRIPINÆ

RHIPIPHOROTHRIPS PULCHELLUS Morgan.

Rhipiphorothrips pulchellus MORGAN, Proc. U. S. Nat. Mus. 46 (1913) 17; MOULTON, Ann. Zool. Jap. 11 (1928) 288; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1802.

[1] Dobutsugaku Zasshi (Zool. Mag. Tokyo) 35 (1921) 80–85; Botany and Zoology, Tokyo 2 (1934) 1827–1835; Journ. Soc. Trop. Agr. Formosa 7 (1935) 67–78; etc.

Food plant.—*Bischofia javanica.*

Habitat.—Taihoku.

This species is common on the lower sides of the leaves, which show discoloration of both surfaces. Sometimes occurs in large numbers, and the males are much fewer than the females.

HELIOTHRIPS HÆMORRHOIDALIS Bouché.

Heliothrips hæmorrhoidalis Bouché, PRIESNER, Thysan. Europ. 1 (1926) 126; TAKAHASHI, Journ. Soc. Trop. Agr. Formosa 7 (1935) 74; STEELE, Commonwealth Austr., Council for Sci. & Indust. Res., Pamph. 54 (1935) 16; RIVNAY, Bull. Ent. Res. 26 (1935) 267; Bull. Soc. Roy. Ent. Egypte (1935) 119. (Other citations are given in Priesner's and Takahashi's papers.)

Food plants.—*Acacia confusa, Acer* sp., *Alnus formosana, Areca catechu, Bixa orellana, Camellia thea, Cinnamomum camphora, Citrus* spp., *Coffea arabica, Codiaeum variegatum, Cunninghamia lanceolata, Diospyros kaki, Gardenia florida, Glochidion* spp., *Gossypium indicum, Liquidambar formosana, Machilus* sp., *Meliosma rhoifolia, Maesa formosana, Morus alba, Mangifera indica, Myrica rubra, Prunus* spp., *Polygonum* sp., *Quercus variabilis, Rhododendron* sp., *Sideroxylon ferrugineum, Terminalia catappa.*

Habitats.—Throughout the lowlands, and found also in the mountainous regions (Rimogan near Urai, Habon Musha, Kurasu near Hassensan, Fujieda near Rokki).

This species is very common and sometimes occurs in abundance, causing serious damage. It attacks the leaves only and at times is mixed with *Selenothrips rubrocinctus* Giard; no male has been detected. Many specimens have been taken on cotton, palm, and *Eugenia*, at Koronya, Ponape Island (Japanese South Sea Islands).

HELIONOTHRIPS BRUNNEIPENNIS Bagnall.

Heliothrips brunneipennis BAGNALL, Ann. & Mag. Nat. Hist. 15 (1915) 318.

Helionothrips brunneipennis BAGNALL, Ann. & Mag. Nat. Hist. 10 (1932) 506.

Food plants.—*Colocasia* sp., *Nicotiana tabacum, Prunus* sp.

Habitats.—Urai near Taihoku (July 2, 1931), Yusho near Piyanan (August 13, 1934), Taihoku (December 5, 1935).

Hitherto unrecorded from Formosa. The Formosan specimens have been compared with a cotype by Prof. J. D. Hood.

HERCINOTHRIPS ERRANS Williams.

Hercinothrips errans WILLIAMS, Entom. 49 (1916) 243; PRIESNER, Thysanop. Europ. 1 (1926) 131; KUROSAWA, Kontyu, Tokyo 4 (1930) 113; PRIESNER, Philip. Journ. Sci. 57 (1935) 351.

Food plants.—*Prunus* sp. and a species of the Lauraceæ.

Habitats.—Taihoku, Kabodai near Hassensan, Suisha.

This species is rather common in the mountainous regions, usually being found in small numbers. It has the habit of jumping from the host when disturbed, and the males are much fewer than the females. Not yet discovered on the Orchidaceæ in Formosa, though known to occur on plants of this family in Europe and Japan.

ASTEROTHRIPS ANGULATUS Hood.

Asterothrips angulatus HOOD, Psyche 32 (1925) 50.

Food plants.—*Agalma lutchuense, Ficus* sp.

Habitats.—Taihoku, Sozan near Taihoku, Rimogan, Kuraru.

New to the fauna of Formosa. My specimens have been kindly determined by Dr. H. Priesner.

SELENOTHRIPS RUBROCINCTUS Giard.

Selenothrips rubrocinctus GIARD, Bull. Soc. Ent. Fr. (1901) 263; TAKAHASHI, Journ. Soc. Trop. Agr. Formosa 7 (1935) 75. (Other literature is cited in Takahashi's paper.)

Food plants.—*Acacia confusa, Alnus formosana, Bixa orellana, Camellia sasanqua, Diospyros kaki, Elaeocarpus elliptica, Eugenia jambos, E. uniflora, Glochidion* sp., *Prunus* sp., *Quercus variabilis, Psidium guajava, Wendlandia glabrata.*

Habitats.—Throughout the lowlands.

Common, sometimes occurring in abundance, but not yet found on cacao in Formosa, though known as a serious pest of it in some countries. At times found in groups with *Heliothrips hæmorrhoidalis* Bouché.

CHIROTHRIPINÆ

CHIROTHRIPS TAKAHASHII Moulton.

Chirothrips takahashii MOULTON, Ann. Zool. Jap. 11 (1928) 289.

Food plants.—*Sorghum* sp., *Miscanthus* sp.

Habitats.—Taihoku, Kahodai near Hassensan, Kurasu.

This species inhabits the flowers, and the specimens collected are females only.

ANAPHOTHRIPINÆ

ANAPHOTHRIPS FLAVICINCTUS Karny.

Anaphothrips flavicinctus KARNY, Bull. Jard. Bot. Buitenzorg II 10 (1913) 55; Bull. Deli Proefst. Sumatra 23 (1925) 24; Revue Russ. Ent. 25 (1933) 174; PRIESNER, Philip. Journ. Sci. 57 (1935) 355.

Food plants.—*Setaria italica*, *Sorghum* sp. and another plant of the Gramineæ.

Habitats.—Taihoku, Urai near Taihoku, Shinten, Mako (Pescadores Islands).

This species attacks the flowers and leaves, and sometimes occurs in large numbers on sorghum in the Pescadores Islands.

ANAPHOTHRIPS THEIPERDUS Karny.

Anaphothrips theiperdus KARNY, Treubia 2 (1921) 69; PRIESNER, Thysan. Europ. (1928) 205; MOULTON, Ann. Zool. Jap. 11 (1928) 291.

Food plant.—Unknown in Formosa.

Habitat.—Taihoku.

ANAPHOTHRIPS ORCHIDII Moulton.

Anaphothrips orchidii MOULTON, Bur. Ent. U. S. Dept. Agr., Tech. Ser. 12 (1907) 52; PRIESNER, Thysan. Europ. (1928) 204; MOULTON, Ann. Zool. Jap. 11 (1928) 291; Proc. Haw. Ent. Soc. 7 (1928) 107, 132.

Food plant.—*Machilus* sp.

Habitats.—Chikushiko, Sozan near Taihoku.

In Formosa this species is not found on orchids, but feeds on the leaves of the young trees of *Machilus* sp. The leaves are rolled along the margin, with the lower surface in.

SCIRTOTHRIPS DORSALIS Hood.

Scirtothrips dorsalis HOOD, Insec. Inscit. Menst. 7 (1919) 90; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 251; RAMAKRISHNA AYYAR and MARGABANDHU, Journ. Bombay Nat. Hist. Soc. 34 (1931) 1032; PRIESNER, Bull. Soc. Roy. Ent. Egypte (1932) 151, 153.

Food plants.—*Arachis hypogaea*, *Mangifera indica*, *Fragaria chiloensis*.

Habitats.—Tainan, Taihoku.

Sometimes occurs in large numbers on leaves, but not so injurious. Near Taihoku sometimes rather common on the upper sides of leaves of strawberry plants in December, and found to breed on the tea plant at Kyoto, Japan, from where it has not been recorded.

THRIPINÆ

AYYARIA CHÆTOPHORA Karny.

Ayyaria chætophora KARNY, Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 193; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 256.

Food plants.—*Glycine, Canavalia*, and other Leguminosæ, and *Gossypium indicum*.

Habitats.—Taihoku, Kyukyokudo near Heito.

This species commonly feeds on the lower sides of leaves of cultivated beans, and many adults are seen on the leaves of cotton. Compared with the holotype by Dr. H. Priesner.

FRANKLINIELLA FORMOSÆ Moulton.

Frankliniella formosæ MOULTON, Ann. Zool. Jap. 11 (1928) 291; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 21; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1895.

Food plants.—*Arachis hypogaea, Bauhinia* sp., *Citrus* spp., *Cucumis* sp., *Cucurbita moschata, Gossypium indicum, Ipomoea batatas, Lagerstroemia indica, Luffa cylindrica, Melastoma candidum, Rosa* spp., *Saccharum officinarum, Styrax suberifolium*, and other species.

Habitats.—Taihoku, Shinko, Kyuko near Shinchiku, Tosei, Kagi, Shinka, Tainan, Takao, Heito, Chippon near Taito.

Very common in the flowers of a wide range of plants, but usually very rare on the Gramineæ. The females much outnumber the males.

FRANKLINIELLA GOSSSYPII (Shiraki).

Euthrips gossypii SHIRAKI, Agr. Exp. Sta. Formosa, Special Rept. 5 (1912) 65.

Food plant.—*Gossypium indicum*.

Habitats.—Kagi, Heito.

Closely allied to *F. formosæ* Moulton, but differing in the paler, smaller, and less sclerotized body. Pale yellow, prothorax darker, pterothorax somewhat reddish, abdomen dusky on the apical part. Found in the flowers and on the lower sides of leaves of cotton, while *F. formosæ* Moulton is found in the flowers only.

TÆNIOTHRIPS LEFROYI Bagnall.

Tæniothrips lefroyi BAGNALL, Ann. & Mag. Nat. Hist. VIII 12 (1913) 292; BAGNALL, Bull. Ent. Res. 9 (1918) 63; MOULTON, Ann. Zool. Jap. 11 (1928) 301; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India,

Ent. Ser. 10 (1928) 258; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 23; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 282.

Food plants.—*Camellia thea, C. japonica, Styrax suberifolium.*

Habitats.—Taihoku, Hoppo, Gyochi, Chippon near Taito.

Found only in the flowers, common on *Camellia*, and a single male has been taken on *Styrax*.

TÆNIOTHRIPS VARICORNIS Moulton.

Tæniothrips varicornis MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 292; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1895; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 276.

Food plants.—*Luffa cylindrica, Mangifera indica, Persea gratissima.*

Habitats.—Taihoku, Kagi, Kuraru near Koshun.

Very rare in the northern part of the island. Found only in the blossoms.

TÆNIOTHRIPS DISTALIS Karny.

Tæniothrips distalis KARNY, Archiv f. Naturg. 79 (1913) 122; Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 196; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 256; MOULTON, Ann. Zool. Jap. 11 (1928) 297; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 20; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 275.

Tæniothrips longistylus KARNY, Journ. Siam Soc. 16 (1923) 99; Bull. Ent. Res. 16 (1925) 126; Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 196; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 258; MOULTON, Ann. Zool. Jap. 11 (1928) 301; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 275; FULLAWAY, Proc. 5th Pacific Sci. Congr. Canada 1933 5 (1934) 3441.

Food plants.—*Crotalaria, Astragalus, Tephrosia, Phaseolus, Vigna, Dolichos, Vicia,* and other Leguminosæ, *Nicotiana tabacum, Ipomoea* sp., *Luffa cylindrica,* and other species.

Habitats.—Throughout the lowlands of Formosa, and some mountainous regions (Urai near Taihoku, Shikikun near Taiheisan, Kurasu near Hassensan, Matsumine near Saramao, Fujieda near Rokki); Botel Tobago (Kotosho).

This species is abundant through the year in the flowers of various legumes, but is found in small numbers on other plants. It has not been detected on the leaves in Formosa, though some were observed attacking the lower sides of the leaves of a bean at Nago, Okinawa, Loochoo, April 27, 1930.

The males appear in any season, but are much fewer than the females. In *T. distalis* the fore femora and the third an-

tennal segment are quite dark, whereas in *T. longistylus* the fore femora are light in color within and the third antennal segment is at least paler than other segments; but there is recognized no morphological difference between them. Moreover, these two are found together in the same flowers in Formosa, the latter form being the commoner.

Many females belonging to the form *longistylus* were collected on *Tephrosia* at Koronya, Ponape Island (Japanese South Sea Islands), August 26, 1933. The species has been known from Fiji and Sunda Islands, but not from Ponape Island.

TÆNIOTHRIPS CLARUS Moulton.

> *Tæniothrips clarus* MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 287; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 22; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 281.

Food plant.—*Raphanus acanthiformis.*

Habitat.—Taihoku.

TÆNIOTHRIPS CANAVALLÆ Moulton.

> *Tæniothrips canavaliæ* MOULTON, Ann. Zool. Jap. 11 (1928) 295; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 280.

Food plant.—*Canavalia obtusifolia.*

Habitat.—Botel Tobago (Kotosho).

TÆNIOTHRIPS FORMOSÆ Moulton.

> *Tæniothrips formosæ* MOULTON, Ann. Zool. Jap. 11 (1928) 298; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 276.

Food plant.—*Canavalia obtusifolia.*

Habitat.—Botel Tobago (Kotosho).

TÆNIOTHRIPS KOTOSHOI Moulton.

> *Tæniothrips kotoshoi* MOULTON, Ann. Zool. Jap. 11 (1928) 300; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 284.

Food plant.—*Canavalia obtusifolia.*

Habitat.—Botel Tobago (Kotosho).

TÆNIOTHRIPS GRACILIS Moulton.

> *Tæniothrips gracilis* MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 289; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 23; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 272, 283.

Food plant.—One of the Leguminosæ.

Habitat.—Taihoku.

TÆNIOTHRIPS COGNATICEPS Priesner.

Tæniothrips cognaticeps PRIESNER, Stylops 4 (1935) 127.

Food plants.—*Torenia concolor, Languas* sp.

Habitats.—Shinten, Urai, Rarasan, Sozan, Taiheisan, Taroko, Miharashi and Miyama near Chippon, Chushinron near Rokki.

Very common in the mountainous regions; attacks the flowers. A few specimens have been taken in the blossoms of *Melastoma* sp. at Gusuku, Amamioshima, Loochoo.

TÆNIOTHRIPS OREOPHILUS Priesner.

Tæniothrips oreophilus PRIESNER, Philip. Journ. Sci. 57 (1935) 355.

Food plants.—*Torenia concolor* and a plant of the Rosaceæ.

Habitats.—Rarasan, Taiheisan, Muroruafu, Matsumine, Arisan.

Common in the mountainous regions; some specimens were taken at Ubasa, Oita Prefecture, Japan.

TÆNIOTHRIPS SULFURATUS Priesner.

Tæniothrips sulfuratus PRIESNER, Philip. Journ. Sci. 57 (1935) 358.

Food plants.—*Camellia japonica, Clerodendron* sp., *Narcissus tazetta.*

Habitats.—Taihoku, Shinten, Matsumine.

TÆNIOTHRIPS SMITHI (Zimmerman).

Physopus smithi ZIMMERMAN, Bull. Inst. Bot. Buitenzorg 7 (1900) 10.
Tæniothrips smithi STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 288; PRIESNER, Philip. Journ. Sci. 57 (1935) 356.

Food plants.—Orchids.

Habitats.—Taihoku, Hori.

Always found in the flowers; common at Hori, central Formosa.

TÆNIOTHRIPS ARALIÆ sp. nov.

Female.—Dirty pale yellow, slightly deeper in color on thorax. Eyes black; ocelli orange-yellow, dark pink on the crescents. First antennal segment pale whitish yellow, second dusky throughout, third dusky, pale whitish yellow on basal and distal parts, fourth dusky except on basal small pale part, fifth to eighth dusky, fifth slightly paler on basal small part. Second to sixth abdominal tergites with a broad, obscure, somewhat pale brown band along anterior margin, which is not well defined on hind border; anterior margins of these tergites narrowly brownish except on lateral part and a very thin transverse gray line behind brownish margin. Legs pale yellow,

tarsi paler, with tips dusky. Wings pale brown, forewings with a very small, indistinct, clear area behind the forevein near base. Prominent setæ on body and wings brownish black. Head slightly wider than long, somewhat constricted behind eyes, slightly arched on cheeks, slightly constricted basally, a little protruding anteriorly, and widely and distinctly divided at front end between antennæ, with some thin, indistinct, transverse striæ on posterior part. Eyes slightly protruding, much narrower than vertex, much longer than half length of cheeks, with some curved setæ, distinctly diverging on the mesal margins except on posterior part; facets large, six, arranged on lateral margin. Ocelli closely placed between posterior halves of eyes, as wide as crescents, posterior ocelli larger than anterior, well separated from eyes, ocellar triangle much wider than long; interocellar bristles very long, very stout, inserted between posterior ocelli, very slightly curved, strongly diverging, as stout as postangular bristles of pronotum, in contact with mesal sides of ocelli, about 0.056 mm long. Postocular setæ short, thin, nearer to eyes than to cheeks, about 0.014 mm long; three similar lateral setæ behind each eye; two pairs of short thin setæ also in front of ocelli; two pairs of very long setæ on anterior part of venter of head. Antennæ about twice as long as head, a little separated from eyes; first segment wider than long; second constricted on basal part, much longer than wide, with six or seven very long setæ; third narrowest at base, broadest on middle swollen part, constricted on distal part, 2.5 times as long as wide, with three or four very long setæ, and a pair of sensory cones which reach basal part of fourth; fourth similar in shape to third, about 2.5 times as long as wide, with three very long setæ and a pair of sensory cones; fifth a little narrowed towards base, not swollen, constricted basally, twice as long as wide, with about four very long setæ which are shorter than those on fourth; sixth about 2.2 times as long as wide, with a simple sense cone arising from about the middle and reaching apex of eighth; seventh as long as wide, narrowed distally; eighth twice as long as wide, 1.5 times as long as seventh; lengths (and widths) of segments as follows: III, 0.069 mm (0.028 mm); IV, 0.065 (0.026); V, 0.037 (0.018); VI, 0.046 (0.021); VII, 0.009 (0.009); VIII, 0.014 (0.007). Pronotum about 1.7 times as wide as long, nearly as long as head, rounded on lateral margin, with rounded corners, hind margin slightly shorter than anterior, with six bristles; over fifty, somewhat curved, rather long setæ scattered

on pronotum except on a pair of large, median, circular areas behind middle, setæ about 0.019 to 0.023 mm long; two setæ on anterior angles, curved, as long as dorsal ones; postangular setæ very long, very stout, pointed, equal in length, about twice as long as median pair of setæ on hind margin, about 0.069 mm long; pterothorax a little wider than pronotum, median bristles on metanotum, far separated from anterior margin, a little curved, about 0.51 mm long. Abdomen broadest on middle, a little wider than thorax, second to eighth tergites with two pairs of setæ, which are much shorter on anterior segments, median pair of setæ on eighth tergite about 0.055 mm long; eighth segment completely set with teeth on hind margin; ninth segment with two pairs of long stout dorsal setæ, two pairs of smaller ventral setæ, and two pairs of long lateral ones, which are longer than segment; tenth segment with two pairs of very long stout setæ, which are shorter than lateral ones on ninth, but longer than dorsal ones on ninth; postangular bristles long, very stout, pointed, a little curved, about 0.069 mm long on sixth segment; sternites without accessory setæ. Wings reaching eighth abdominal segment, forewings with seven basal and two distal setæ on forevein, thirteen setæ on hind vein, and twenty-five setæ on front margin, which are very stout, mostly a little curved, and those on veins about 0.059 mm long; one of the marginal setæ near tip much thinner; double fringe of hairs not observable in my specimen. Legs with many short setæ; femora nearly as long as tibiæ, fore tibiæ about four times as long as wide. Body about 1.5 mm, head about 0.148 mm long, about 0.162 mm wide, antenna about 0.3 mm long, narrowest width of vertex between eyes about 0.069 mm, pronotum about 0.222 mm wide, mesothorax about 0.286 mm wide, fore tibia about 0.16 mm long, lateral bristles (upper pair) on ninth abdominal segment about 0.129 mm long.

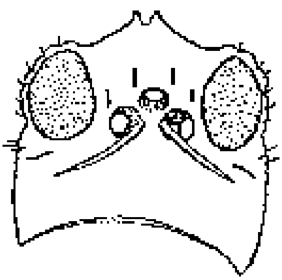

FIG. 1. *Taeniothrips araliae* sp. nov.; head of adult female.

Food plant.—*Aralia bipinnata.*

Habitat.—Asahi (Taito-cho).

A single specimen was taken by me in the flower, May 16, 1935. This species is characterized by the very large interocellar bristles and the shape of the front of head. In Steinweden's

key to the species of *Tæniothrips* [2] this thrips runs to group II B, but differs from all the species in it, as well as from all species not included in the key. It is easily distinguished from *T. glycines* Okam. by the colors of body and antennæ, the shorter sixth antennal segment, the pale brown wings, the shorter pronotum, and other characters. The type is in the collection of the Department of Agriculture Research Institute, Formosa.

TÆNIOTHRIPS ALLIORUM Priesner.

Tæniothrips alliorum PRIESNER, Stylops 4 (1935) 128.

Food plant.—*Allium fistulosum*.

Habitats.—Taihoku, Heito; Naha, Okinawa, Loochoo.

Common, but occurring in restricted numbers.

THRIPS TABACI Lindeman.

Thrips tabaci Lindeman, KARNY, Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 199; PRIESNER, Thysan. Europ. 3 (1927) 433; TAKAHASHI, Journ. Soc. Trop. Agr. Formosa 7 (1935) 76; STEELE, Commonwealth Austr., Council for Sci. & Indust. Res., Pamph. 54 (1935) 46. (Other citations are given in Priesner's and Takahashi's papers.)

Food plants.—*Allium* spp.

Habitats.—Throughout the lowlands.

In Formosa this species is confined to onions, no specimens having been found on other plants, though the species is extensively polyphagous in other countries. It is very common on the leaves and flowers from April to June near Taihoku and much reduced in numbers during winter; no male has been discovered.

THRIPS FORMOSANUS Priesner.

Thrips formosanus PRIESNER, Natuurkund. Tijdschr. v. Nederl.-Ind. 94 (1934) 283.

Food plants.—*Viola* sp., *Lilium* sp., and other species.

Habitats.—Taiheisan, Niitaka-yama (Mount Morrison). Hinokiyama and Takimi (Takao Prefecture), Izumo (Taito-cho).

Common in the flowers on high mountains.

THRIPS KARNYIANUS Priesner.

Thrips karnyianus PRIESNER, Natuurkund. Tijdschr. v. Nederl.-Ind. 94 (1934) 282.

Food plant.—*Bambusa?*

Habitat.—Naii (Takao Prefecture).

[2] Trans. Am. Ent. Soc. 59: 260.

THRIPS ORYZÆ Williams.

Thrips oryzæ WILLIAMS, Bull. Ent. Res. 6 (1916) 353; KARNY, Journ. Siam Soc. 16 (1923) 109; MOULTON, Ann. Zool. Jap. 11 (1928) 303; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 263; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1894; RAMAKRISHNA AYYAR, Agr. & Live-stock India 2 (1932) 395; PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 289.

Food plants.—*Oryza sativa*, *Zea mays*.

Habitat.—Taihoku.

Not common, rarely occurring in abundance.

THRIPS HAWAIIENSIS (Morgan).

Euthrips hawaiiensis MORGAN, Proc. U. S. Nat. Mus. 46 (1913) 3.

Thrips hawaiiensis PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 266.

Tæniothrips hawaiiensis MOULTON, Proc. Haw. Ent. Soc. 7 (1928) 132; STEINWEDEN, Trans. Am. Ent. Soc. 59 (1933) 286.

Thrips albipes BAGNALL, Ann. & Mag. Nat. Hist. VIII 13 (1914) 25; Ent. Month. Mag. 64 (1928) 101; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India. Ent. Ser. 10 (1928) 261; MOULTON, Ann. Zool. Jap. 11 (1928) 302; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 24.

Tæniothrips pallipes MOULTON, Ann. Zool. Jap. 11 (1928) 302.

Food plants.—*Acacia confusa*, *Allium fistulosum*, *Callicarpa formosana*, *Camellia* spp., *Citrus* spp., *Aralia* sp., *Castanea* sp., *Clerodendron* spp., *Cirsium* spp., *Chrysanthemum coronarium*, *Eria nudicaulis*, *Gardenia florida*, *Gordonia anomala*, *Gossypium indicum*, *Echinochloa crusgalli*, *Hibiscus rosa-sinensis*, *H. syriacus*, *Ipomoea batatas*, *Jasminum* sp., *Ligustrum japonicum*, *Lilium* sp., *Luffa cylindrica*, *Lantana* sp., *Morus alba*, *Mallotus* spp., *Murraya* spp., *Musa sapientum*, *Melastoma candidum*, *Michelia* spp., *Miscanthus* sp., *Nerium indicum*, *Narcissus tazetta*, *Nephelium litchi*, *Psidium guajava*, *Phoenix hanceana*, *Passiflora* sp., *Papaver somniferum*, *Plumiera acuminata*, *Peucedanum japonicum*, *Raphanus* sp., *Sansevieria zeylanica*, *Sambucus* sp., *Saccharum officinarum*, *Tephrosia* sp., *Vigna* sp., *Zea mays*, etc.

Habitats.—Throughout the lowlands and some mountainous regions (Urai, Kurasu and Kahodai near Hassensan, Funkiko, Asahi and Kakayo, Taito-cho, Habon near Musha, Fujieda near Rokki); Mako, the Pescadores Islands.

This species is the most dominant and polyphagous thrips in Formosa and is common in Loochoo and Japan. It feeds on a very wide range of plants, including the Gramineæ, but has not been found on the Gymnospermæ or the Orchidaceæ. The species attacks the flowers only, and is very injurious to the poppy. The males are as common as the females.

THRIPS FLORUM Schmutz.

Thrips florum SCHMUTZ, Sitzungsber. Kaiserl. Akad. Wissensch. Wien, mathem.-naturw. Klasse 122 (1913) 13; KARNY, Archiv f. Zool. 17 (1924) 13; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 261; Rec. Ind. Mus. 34 (1932) 277; 36 (1934) 493; PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 261; STEELE, Commonwealth Austr., Council for Sci. & Indust. Res., Pamph. 54 (1935) 39.

Food plants.—*Citrus limonum*, *Styrax suberifolium*.

Habitats.—Taito, Chippon.

Not common, always inhabiting the flowers.

THRIPS CLARUS Moulton.

Thrips clarus MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 294.

Food plants.—*Allium fistulosum*, *Bidens pilosa*, *Cucumis sativus*, *Cirsium* sp., *Chrysanthemum coronarium*, *Setaria italica*, *Ipomoea batatas*, *Gossypium indicum*, *Lilium* sp., *Lantana* sp., *Miscanthus* sp., *Polygonum* sp., *Viola* sp., *Zea mays*, various legumes, and other species.

Habitats.—Throughout the lowlands, and some mountainous regions (Chakon near Urai, Rarasan, Shikikun near Taiheisan, Kahodai near Hassensan, Arisan, Funkiko, Musha, Marikowan, Hakku, Kotobuki and Izumo, Taito-cho, Hinokiyama, Takao Prefecture).

Very common; usually found in the flowers, but sometimes attacking the leaves of cotton and the flower buds of the lily.

THRIPS EXTENSICORNIS Priesner.

Thrips extensicornis PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 270.

Thrips pallipes MOULTON (nec Bagnall), Ann. Zool. Jap. 11 (1928) 303.

Food plants.—*Clerodendron* sp. and a plant of the Compositae.

Habitats.—Taihoku, Tansui, Shirin, Daiton-san.

Not common, feeding on the flowers.

THRIPS (ISONEUROTHRIPS) ADDENDUS Priesner.

Thrips (Isoneurothrips) addendus PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 270.

Food plants.—One of the Compositae, and other species.

Habitats.—Shijukei, Botanwan, Kuraru, Banro.

Common in the flowers of various plants in the southernmost part of the island, but not found elsewhere. The males are common.

THRIPS (ISONEUROTHRIPS) TAIWANUS nom. nov.

Isoneurothrips pallipes MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 296.

Food plant.—A plant of the Leguminosæ.

Habitat.—Hori.

Moulton's name is preoccupied by *Thrips pallipes* Bagnall.

THRIPS (ISONEUROTHRIPS) SETIPENNIS Moulton.

Thrips (Isoneurothrips) setipennis MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 297.

Food plant.—Unknown.

Habitats.—Taihoku, Botel Tobago (Kotosho).

THRIPS (MICROCEPHALOTHRIPS) ABDOMINALIS Crawford.

Thrips abdominalis CRAWFORD, Pomona Coll. Journ. Ent. 2 (1910) 157; WATSON, Florida Agr. Exp. Sta. Bull. 168 (1923) 44.

Microcephalothrips abdominalis BAGNALL, Ann. & Mag. Nat. Hist. IX 13 (1926) 114; MOULTON, Ann. Zool. Jap. 11 (1928) 305; STEINWEDEN and MOULTON, Proc. Nat. Hist. Soc., Fukien Christ. Univ. China 3 (1930) 27; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1893.

Thrips (Ctenothripella) abdominalis MOULTON, Proc. Haw. Ent. Soc. 7 (1928) 110, 132.

Food plants.—*Ageratum conyzoides, Chrysanthemum coronarium*, another plant of the Compositæ, and a plant of the Leguminosæ.

Habitats.—Taihoku, Hichiseisan, Kinpori, Kiirun, Tonroku near Urai; Mako, the Pescadores Islands.

THRIPS (FULMEKIOLA) SERRATUS (Kobus).

Physothrips serratus KOBUS, Meded. Proefst. Oost-Java 43 (1892). (Not available.)

Phloeothrips pallidicornis MATSUMURA (part.). Schäd. u. nützl. Insekt. d. Zuckerrohrs Formosas (1910) 11.

Stenothrips minutus KARNY, Zeits. wiss. Insectenbiol. 11 (1915) 85; MOULTON, Ann. Zool. Jap. 11 (1928) 307; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1893.

Thrips moultoni ISHIDA, Insecta Mats. Sapporo 9 (1934) 55.

Thrips (Saccharothrips) serratus PRIESNER, Natuurk. Tijdschr. v. Nederl.-Ind. 94 (1934) 280.

Food plant.—*Saccharum officinarum.*

Habitats.—Taihoku, Shinka, Tainan, Zenka.

Sometimes occurs in large numbers on the leaves and in the flowers, but is usually less numerous than other species on sugar cane.

ISOCHÆTOTHRIPS QUERCI Moulton.

Isochætothrips querci MOULTON, Ann. Zool. Jap. 11 (1928) 307.

Food plant.—*Quercus* sp.
Habitat.—Taihoku.

BOLACOTHRIPS ORIENTALIS Priesner.

Bolacothrips orientalis PRIESNER, Philip. Journ. Sci. 57 (1935) 359.

Food plant.—*Allium fistulosum.*
Habitat.—Taihoku.

PARABALIOTHRIPS TAKAHASHII Priesner.

Parabaliothrips takahashii PRIESNER, Stylops 4 (1935) 125.

Food plant.—*Liquidambar formosana.*
Habitat.—Kanko near Shinten.
Attacks the lower sides of the leaves.

PARABALIOTHRIPS GRANDICEPS Priesner.

Parabaliothrips grandiceps PRIESNER, Stylops 4 (1935) 126.

Food plant.—*Quercus* sp.
Habitat.—Reimei at Hassensan.

DOCIDOTHRIPS IMITANS Priesner.

Docidothrips imitans PRIESNER, Stylops 4 (1935) 127.

Food plant.—*Psidium guajava.*
Habitat.—Kuraru near Koshun.

TUBULIFERA

PHLŒOTHRIPIDÆ

PHLŒOTHRIPINÆ

GYNAIKOTHRIPS UZELI Zimmerman.

Gynaikothrips uzeli ZIMMERMAN, Bull. Inst. Bot. Buitenzorg 7 (1900) 12; KARNY, Centralbl. f. Bakter., Parasitenk. u. Infektionskr. 30 Abteil. 2 (1911) 561; Marcellina 11 (1912) 129; Hood, Insec. Inscit. Menstr. 1 (1913) 153; KARNY and LEEUWEN, Bull. Jardin Bot. Buitenzorg 10 (1913) 103; KARNY, Zeits. f. wiss. Insectenbiol. 20 (1915) 327; 21 (1916) 89; TAKAHASHI, Trans. Nat. Hist. Soc. Formosa 12 (1922) 30; KARNY, Treubia 3 (1922) 325; Journ. Siam Soc. 16 (1923) 145; WATSON, Florida Agr. Exp. Sta. Bull. 168 (1923) 68; MOULTON, Ann. Zool. Jap. 11 (1928) 315; RAMAKRISHNA AYYAR and MARGABANDHU, Journ. Bombay Nat. Hist. Soc. 34 (1931) 1040; PRIESNER, Rev. Zool. Bot. Africa 22 (1932) 196; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1829.

Liothrips sp. MAKI, Forest Exp. Sta. Formosa, Spec. Rept. 1 (1915) 16.

Cryptothrips sp. TAKAHASHI, Dobuts. Zasshi (Zool. Mag. Tokyo) 35 (1921) 82.

Gynaikothrips flavus ISHIDA, Insecta Mats. Sapporo 6 (1931) 40.

Gynaikothrips sp. TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1830.

Food plants.—*Ficus retusa, F. swinhoei.*

Habitats.—Throughout the lowlands; Mako, the Pescadores Islands.

Very common in Formosa and Loochoo on *Ficus retusa*, rolling the leaves. The galls of this species are inhabited by the inquilines *Mesothrips jordani* Zimmerman, *Androthrips ramachandrai* Karny, *Haplothrips inquilinus* Priesner, *Smerinthothrips takahashii* Moulton, and other species.

SMERINTHOTHRIPS VITIVORUS Priesner.

Smerinthothrips vitivorus PRIESNER, Philip. Journ. Sci. 57 (1935) 364.

Gynaikothrips claripennis MOULTON (nec Karny), Ann. Zool. Jap. 11 (1928) 308; ISHIDA, Insecta Mats. Sapporo 6 (1931) 39; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1829.

Gynaikothrips sp. TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1828, 1832.

Food plant.—*Vitis shifunensis.*

Habitats.—Throughout the lowlands.

This species is common wherever the host plant grows, rolling the leaves; and the galls are invaded by *Haplothrips inquilinus* Priesner.

SMERINTHOTHRIPS LILIACEÆ (Moulton).

Gynaikothrips liliaceæ MOULTON, Ann. Zool. Jap. 11 (1928) 310; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1832.

Food plants.—*Smilax* spp.

Habitats.—Taihoku, Urai, Shinten, Sekitae, Kannonsan, Hori, Kahodai near Hassensan, Daijurin near Shinsuiei, Kuraru near Koshun.

FIG. 2. *Smerinthothrips liliaceæ* Moulton; gall.

This species is very common, rolling the leaves, and is sometimes found with *Smerinthothrips kuwanai* (Moulton) in the galls. Many specimens have been taken on *Smilax* at Iriomote,

Loochoo. The males are common, but usually less numerous than the females.

SMERINTHOTHRIPS YUASAI (Moulton).

Gynaikothrips yuasai MOULTON, Ann. Zool. Jap. 11 (1928) 315.

Food plant.—Unknown.

Habitat.—Domon near Karenko.

SMERINTHOTHRIPS KUWAYAMAI (Moulton).

Gynaikothrips kuwayamai MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 302.

Food plant.—*Viburnum arboricolum.*

Habitats.—Karapin, Koshun.

Found on the lower sides of the leaves.

SMERINTHOTHRIPS SIAMENSIS (Karny).

Gynaikothrips siamensis KARNY, Treubia 3 (1923) 349; Journ. Siam Soc. 16 (1923) 133; Mem. Dept. Agr. India 9 (1926) 236.

Food plants.—*Lithocarpus* sp., *Quercus* sp.

Habitats.—Suisha, Kahodai near Hassensan.

Found in small numbers on the lower surface of the leaves.

SMERINTHOTHRIPS CITRICORNIS (Moulton).

Gynaikothrips citricornis MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 300.

Food plant.—*Liquidambar formosana.*

Habitats.—Taihoku, Shirin.

Attacks the lower surface of the leaves.

SMERINTHOTHRIPS TAKAHASHII (Moulton).

Gynaikothrips takahashii MOULTON, Ann. Zool. Jap. 11 (1928) 313; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1891; Bot. & Zool. Tokyo 2 (1934) 1829.

Food plant.—*Ficus retusa.*

Habitats.—Taihoku, Kikamon near Boryo.

Always found in the galls of *Gynaikothrips uzeli* Zimmerman, being very common in Formosa and Loochoo including Amamioshima.

SMERINTHOTHRIPS KUWANAI (Moulton).

Gynaikothrips kuwanai MOULTON, Ann. Zool. Jap. 11 (1928) 308; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1831.

Mesothrips claripennis TAKAHASHI (nec Moulton), Iconogr. Insect. Japon. (1932) 1890.

Food plants.—*Piper futokadsura, Smilax china, Smilax* sp.

Habitats.—Taihoku, Shinten, Sekitae, Sozan, Urai, Rarasan, Oryukei near Tosei, Habon near Musha, Daijurin near Shin-

suiei, Koshun, Kikamon near Boryo, Kuraru, Chippon, Kowarun, Botanwan, Tachibana (Taito-cho).

This species is very common, especially on *Piper futokadsura*, forming galls on both food plants. Sometimes found associated with *Smerinthothrips liliaceæ* Moulton in the galls on *Smilax*, while the galls on *Piper* are inhabited by the inquilines *Liothrips piperinus* Priesner and *Haplothrips inquilinus* Priesner. The galls on *Smilax* are similar in shape to those of *Smerinthothrips liliaceæ* Moulton.

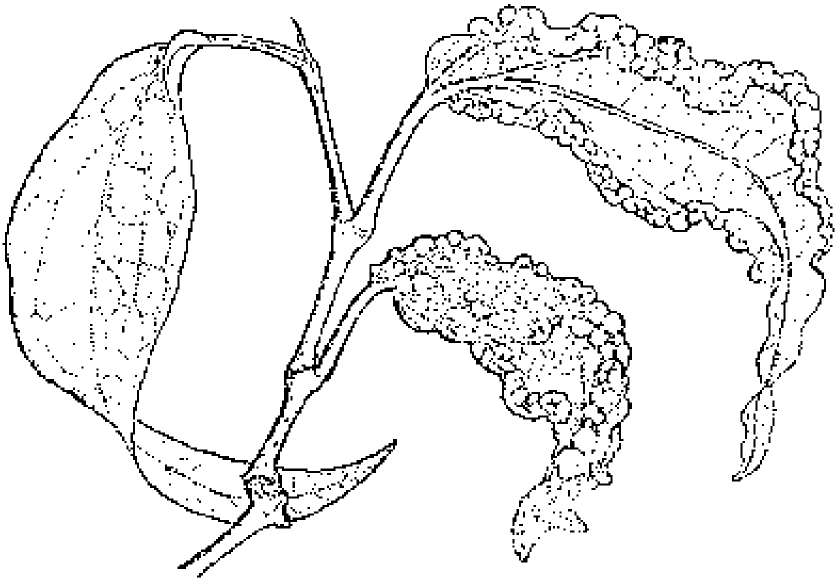

FIG. 3. *Smerinthothrips kuwanai* (Moulton); galls.

NEOSMERINTHOTHRIPS FORMOSENSIS Priesner.

Neosmerinthothrips formosensis PRIESNER, Philip. Journ. Sci. 57 (1935) 368.

Food plant.—Unknown.

Habitats.—Mako, the Pescadores Islands.

LITOTETOTHRIPS ROTUNDUS (Moulton).

Gynaikothrips rotundus MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 304; Ann. Zool. Jap. 11 (1928) 331.
Litotetothrips cinnamomi PRIESNER, Treubia 10 (1929) 4.

Food plant.—*Cinnamomum camphora.*

Habitat.—Taihoku.

Very scarce, occurring in restricted numbers in the buds and on the young shoots.

HOPLOTHRIPS FUNGOSUS Moulton.

Hoplothrips fungosus MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 305.

Food plants.—*Polysticlus* sp., and other fungi of the Polyporaceæ.

Habitats.—Taihoku, Kagi, Keiko near Karenko.

Sometimes found mixed with *Hoplothrips japonicus* Karny.

HOPLOTHRIPS JAPONICUS (Karny).

Dorcothrips japonicus KARNY, Archiv f. Naturgesch. 79 Abteil. A (1913) 126; MOULTON, Ann. Zool. Jap. 11 (1928) 330.

Food plants.—Fungi of the Polyporaceæ.

Habitats.—Taiheisan, Keiko near Karenko, Chipponsan, Kuraru.

Sometimes occurs in large numbers, grouping with *Hoplothrips fungosus* Moulton.

HOPLOTHRIPS (ODONTOPLOTHRIPS) DENTIFER Priesner.

Hoplothrips (*Odontoplothrips*) *dentifer* PRIESNER, Philip. Journ. Sci. 57 (1935) 365.

Hoplothrips sp. TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1833.

Food plants.—*Bladhia sieboldii, Clerodendron* sp.

Habitat.—Taihoku.

Found associated with *Mesothrips claripennis* Moulton on *Bladhia*, and in the flowers of *Clerodendron*. Also taken at Nishinakama, Amamioshima, Loochoo.

CRYPTOTHRIPS MAGNUS Moulton.

Cryptothrips magnus MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 290; Ann. Zool. Jap. 11 (1928) 329.

Food plant.—Unknown.

Habitat.—Kotosho (Botel Tobago).

CRYPTOTHRIPS SAUTERI Karny.

Cryptothrips sauteri KARNY, Suppl. Ent. 2 (1913) 127; MOULTON, Ann. Zool. Jap. 11 (1928) 330.

Food plant.—Unknown.

Habitat.—Kankau.

LIOTHRIPS PIPERINUS Priesner.

Liothrips piperinus PRIESNER, Philip. Journ. Sci. 57 (1935) 361.

Food plant.—*Piper futokadsura.*

Habitats.—Rarasan near Urai, Habon near Musha, Chippon, Botanwan.

Always found in the galls of *Smerinthothrips kuwanai* Moulton, but in far fewer numbers than the host species.

LIOTHRIPS FLORIDENSIS (Watson).

Cryptothrips floridensis WATSON, Ent. News 24 (1913) 145; 26 (1915) 52; Florida Agr. Exp. Sta. Bull. 168 (1923) 69, 70; MOULTON, Ann. Zool. Jap. 11 (1928) 329.

Liothrips floridensis WATSON, Florida Ent. 9 (1925) 39.

Food plant.—*Cinnamomum camphora.*

Habitat.—Taihoku.

In Formosa this species is very scarce, being found singly or in very small numbers on the distal ends of the young shoots or in the leaf buds; however, it is very injurious in Florida, North America.

LIOTHRIPS BREVITUBUS Karny.

Liothrips brevitubus KARNY, Marcellia 11 (1912) 156; TAKAHASHI, Bot. & Zool. 2 (1934) 1829.

Liothrips malloti MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 308; Ann. Zool. Jap. 11 (1928) 332; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1891.

Food plant.—*Mallotus repandus.*

Habitats.—Taihoku, Kannonsan, Daitonsan, Tosei, Rokki.

Very common, shrinking the leaves; sometimes preyed upon by *Hoplothrips inquilinus* Priesner. The Formosan specimens have been compared with the type specimen by Dr. H. Priesner.

LIOTHRIPS BREVITUBUS Karny var. FLAVICORNIS Moulton.

Liothrips brevitubus Karny var. *flavicornis* MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 310.

Food plant.—Unknown.

Habitat.—Taihoku.

LIOTHRIPS HEPTAPLEURINUS Priesner.

Liothrips heptapleurinus PRIESNER, Philip. Journ. Sci. 57 (1935) 360.

Food plant.—*Heptapleurum* sp.

Habitat.—Taihoku.

LIOTHRIPS TERMINALIÆ Moulton.

Liothrips terminaliæ MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 311; Ann. Zool. Jap. 11 (1928) 332.

Food plant.—*Terminalia catappa.*

Habitat.—Koshun.

RHYNCHOTHRIPS (?) MACHILI Moulton.

Rhynchothrips (?) *machili* MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 313.

Food plant.—*Machilus* sp.

Habitat.—Tattaka near Musha.

DOLICHOTHRIPS FLAVIPES (Moulton).

Neoheegeria flavipes MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 317.

Food plant.—*Euphorbia* sp.

Habitat.—Taihoku.

DOLICHOTHRIPS MACARANGAI (Moulton).

Neoheegeria macarangai MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 319; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1889.

Food plant.—*Macaranga tanarius*.

Habitats.—Taihoku, Takao.

Very common, occurring in large numbers in the flowers and among the buds.

DOLICHOTHRIPS PUMILIS Priesner.

Dolichothrips pumilis PRIESNER, Philip. Journ. Sci. 57 (1935) 362.

Food plant.—*Diospyros discolor*.

Habitat.—Nisui.

Attacks the lower sides of the leaves.

PLECTROTHRIPS CORTICINUS Priesner.

Plectrothrips corticinus PRIESNER, Philip. Journ. Sci. 57 (1935) 371.

Habitat.—Taihoku.

Found under the bark of decayed trees.

MESOTHRIPS JORDANI Zimmerman.

Mesothrips jordani ZIMMERMAN, Bull. Inst. Bot. Buitenzorg 7 (1900) 16; KARNY, Journ. Siam Soc. 16 (1923) 145; PRIESNER, Treubia 10 (1929) 453; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1830.

Food plant.—*Ficus retusa*.

Habitats.—Shoka, Gaishatei, Tosei, Nisui, Tainan, Takao, Heito, Daibu.

Always found in the galls of *Gynaikothrips uzeli* Zimmerman; common in the south part of the island but absent in the north. The thrips recorded under the name *Mesothrips pyctes* var. *debilis* Karny, by Moulton,[3] from Formosa, may be this species.

MESOTHRIPS ALLUAUDI Vuillet.

Mesothrips alluaudi VUILLET, Bull. Soc. Ent. France 1914 (1914) 211; MOULTON, Ann. Zool. Jap. 11 (1928) 319.

Food plant.—*Machilus* sp.

Habitat.—Taihoku.

[3] Ann. Zool. Jap. 11 (1928) 318.

MESOTHRIPS CLARIPENNIS Moulton.

Mesothrips claripennis MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 315; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1833.

Food plant.—*Bladhia sieboldii.*

Habitats.—Taihoku, Sozan, Kannonsan. Also found in Amamioshima, Loochoo.

This species is common, rolling the leaves. The galls are invaded by *Hoplothrips inquilinus* Priesner and *Hoplothrips dentifer* Priesner.

ANDROTHRIPS RAMACHANDRAI Karny.

Androthrips ramachandrai KARNY, Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 226; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 301; MOULTON, Ann. Zool. Jap. 11 (1928) 318; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1830.

Food plant.—*Ficus retusa.*

Habitats.—Nisui, Tainan.

Found associated with *Gynaikothrips uzeli* Zimmerman.

HAPLOTHRIPS GOWDEYI Franklin.

Haplothrips gowdeyi FRANKLIN, Proc. U. S. Nat. Mus. 32 (1908) 724; HOOD, Insec. Inscit. Menstr. 1 (1913) 149; Mem. Queensland Mus. 6 (1918) 127; WATSON, Florida Agr. Exp. Sta. Bull. 168 (1923) 60; MOULTON, Ann. Zool. Jap. 11 (1928) 319; Proc. Hawaii. Ent. Soc. 7 (1928) 125, 134; PRIESNER, Bull. Soc. Roy. Ent. Egypte 1929 4 (1929) 216; 1930 4 (1931) 261; Record. Ind. Mus. 35 (1933) 364; MOULTON, Bishop Mus. Bull. 113 (1935) 31.

Food plants.—*Ageratum* sp., *Allium fistulosum*, *Aster lauruleanus*, *Bidens pilosa*, *Celosia* spp., *Chrysanthemum* sp., *Cirsium* sp., *Clerodendron* sp., *Cyperus* sp., *Emilia sonchifolia*, *Gossypium indicum*, *Lantana camara*, *Lactuca debilis*, *Melastoma candidum*, *Oenanthe* sp., *Osmanthus fragrans*, *Rubus illecebrosus*, *Zea mays*, and other species.

Habitats.—Throughout the lowlands; the Pescadores Islands.

Very common in the flowers of various plants.

HAPLOTHRIPS ACULEATUS Fabricius.

Haplothrips aculeatus Fabricius, PRIESNER, Thysan. Europ. (1928) 597; MOULTON, Ann. Zool. Jap. 11 (1928) 319; Record. Ind. Mus. 35 (1933) 366; BAGNALL, Ann. & Mag. Nat. Hist. X 11 (1933) 326.

Phloeothrips pallidicornis MATSUMURA (part.), Schaedl. u. nuetzl. Insekt. d. Zuckerrohrs Formosas (1910) 11.

Phloeothrips pallicornis MATSUMURA, Mem. Soc. Ent. Belg. 18 (1911) 133.

Haplothrips pallicornis MOULTON, Ann. Zool. Jap. 11 (1928) 334.

Food plants.—*Allium fistulosum*, *Celosia argentea*, *Cyperus* sp., *Hibiscus rosa-sinensis*, *Setaria italica*, *Miscanthus* sp., *Oryza*

sativa, *Saccharum officinarum*, *Sorghum* sp., *Spinacia oleracea*, *Zea mays*, and other species.

Habitats.—Taihoku, Hokuto, Shinten, Kagi, Shinka, Zenka, Heito.

Common on sugar cane, at times occurring in large numbers, but scarce on rice; always in the flowers.

HAPLOTHRIPS GANGLBAUERI Schmutz.

Haplothrips ganglbaueri SCHMUTZ, Sitzgsbericht. Akad. Wiss. Wien (1913) 1034; KARNY, Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 217; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 292; PRIESNER, Records Ind. Mus. 35 (1933) 365.

Food plants.—*Setaria italica*, *Cyperus* sp., *Miscanthus* sp., and another plant of the Gramineæ.

Habitats.—Taihoku, Shinten, Ikenohata near Bonbonsan, Hakumo near Tosei, Kahodai near Hassensan.

HAPLOTHRIPS CHINENSIS Priesner.

Haplothrips chinensis PRIESNER, Record. Ind. Mus. 35 (1933) 359.
Haplothrips subtilissimus f. *floricola* MOULTON (nec Priesner), Ann. Zool. Jap. 11 (1928) 320.

Food plants.—*Ageratum* sp., *Astragalus sinicus*, *Allium fistulosum*, *Bidens pilosa*, *Bladhia sieboldii*, *Castanea* sp., *Cirsium* sp., *Clerodendron* sp., *Citrus* spp., *Camellia* spp., *Canna* sp., *Crotalaria saltiana*, *Chrysanthemum* sp., *Cryptotaenia canadensis*, *Gossypium indicum*, *Ipomoea batatas*, *Jasminum* sp., *Lactuca debilis*, *Luffa cylindrica*, *Eria nudicaulis*, *Murraya* sp., *Morus alba*, *Nephelium litchi*, *Narcissus tazetta*, *Oenanthe* sp., *Oxalis violacea*, *Prunus* sp., *Polygonum* sp., *Pueraria thunbergiana*, *Rumex* sp., *Rosa* sp., *Rubus* sp., *Raphanus* sp., *Trifolium repens*, etc.

Habitats.—Taihoku, Hichiseisan, Taiheisan, Urai, Shikikun, Suigen near Rato, Tonroku near Urai, Kyuko near Shinchiku, Hakku near Musha, Inrin, Kagi, Arisan, Tainan, Taito, Taroko; Botel Tobago (Kotosho); the Pescadores Islands.

Very common in the flowers; the Formosan specimens have been examined by Dr. H. Priesner. *Haplothrips subtilissimus* Haliday does not exist in Formosa.

HAPLOTHRIPS CHINENSIS Priesner var. MONTIVAGUS Priesner.

Haplothrips chinensis Priesner var. *montivagus* PRIESNER, Philip. Journ. Sci. 57 (1935) 366.

Food plants.—*Polygonum* spp., *Callicarpa formosana*.

Habitats.—Taihoku, Urai, Taiheisan, Taroko, Kahodai near Hassensan, Arisan, Marikowan near Musha, Aderu and Budai near Heito, Torin (Taito-cho).

Very common in the flowers of *Polygonum*, especially in the mountainous regions.

HAPLOTHRIPS CERTUS Priesner.

Haplothrips certus PRIESNER, Treubia 9 (1929) 194; Record. Ind. Mus. 35 (1933) 353.

Haplothrips formosæ TAKAHASHI, Iconogr. Insect. Japon. (1932) 1890.

Food plants.—*Cyperus* sp. and a plant of the Leguminosæ.

Habitats.—Taihoku, Shinten, Takao; Botel Tobago (Kotosho).

Rather common in the flowers of *Cyperus*. The Formosan specimens have been compared with the types by Dr. H. Priesner.

HAPLOTHRIPS VERNONIÆ Priesner.

Haplothrips ceylanicus var. *vernoniæ* PRIESNER, Treubia 2 (1921) 4, 7; Bull. Deli Proefst. 23 (1925) fig. 17; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 292.

Haplothrips vernoniæ PRIESNER, Record. Ind. Mus. 35 (1933) 360.

Food plants.—*Cucumis sativus*, *Callicarpa formosana*, *Celosia cristata*, *Gossypium indicum*, *Ipomoea batatus*, *Lagerstroemia indica*, *Melastoma candidum*, *Pleuropterus hypoleucus*, *Pueraria thunbergiana*, and other species.

Habitats.—Taihoku, Shinten, Taroko, Kahodai near Hassensan, Heito.

HAPLOTHRIPS VERNONIÆ Priesner var. GRANDIOR Priesner.

Haplothrips vernoniæ Priesner var. *grandior* PRIESNER, Record. Ind. Mus. 35 (1933) 361.

Food plants.—*Cirsium* sp., *Lactuca scariola*, *Momordica charantia*.

Habitat.—Taihoku.

HAPLOTHRIPS ALLII Priesner.

Haplothrips allii PRIESNER, Philip. Journ. Sci. 57 (1935) 367.

Food plant.—*Allium fistulosum*.

Habitat.—Sankaiseki near Takao.

Very rare.

HAPLOTHRIPS LEUCANTHEMI Schrank.

Haplothrips leucanthemi Schrank, PRIESNER, Thysan. Europ. (1928) 614.

Food plant.—*Ficus retusa*.

Habitat.—Mako, the Pescadores Islands (June 4, 1930).

New to the fauna of Formosa. Many specimens were taken on a composite at Kaibato, Saghalien, by Dr. T. Shiraki, July 1930.

At Mako this species was found with *Gynaikothrips uzeli* Zimmerman in the rolled leaves.

HAPLOTHRIPS INQUILINUS Priesner.

Haplothrips inquilinus PRIESNER, Treubia 2 (1921) 4, 6; KARNY, Mem. Dept. Agr. India, Ent. Ser. 9 (1926) 216; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 292; PRIESNER, Record. Ind. Mus. 35 (1933) 349; TAKAHASHI, Bot. & Zool. Tokyo 2 (1934) 1830; RAMAKRISHNA AYYAR, Record. Ind. Mus. 36 (1934) 496.

Habitats.—Taihoku, Daitonsan, Sozan, Matsumine near Saramao, Hori, Taito.

This species is predatory, being found in the galls of other thrips on *Piper futokadsura, Bladhia sieboldii, Mallotus repandus, Vitis shifunensis,* and *Ficus retusa,* but not in those on *Smilax.* Very common, especially on *Piper.*

HAPLOTHRIPS FUSCIPENNIS Moulton.

Haplothrips fuscipennis MOULTON, Ann. Zool. Jap. 11 (1928) 320.

Habitat.—Taihoku.

Found in the galls of *Smerinthothrips kuwanai* (Moulton) on *Piper futokadsura.*

ALEURODOTHRIPS FASCIAPENNIS (Franklin).

Cryptothrips fasciapennis FRANKLIN, Proc. U. S. Nat. Mus. 33 (1908) 727.

Aleurodothrips fasciapennis MOULTON, Ann. Zool. Jap. 11 (1928) 322; TAYLOR, Bull. Ent. Res. 26 (1935) 53.

Habitats.—Taihoku, Kosuiko near Tainan.

This species is predatory and is found on *Citrus, Osmanthus,* and *Bischofia.* Very scarce.

LEEUWENIA PUGNATRIX Priesner.

Leeuwenia pugnatrix PRIESNER, Philip. Journ. Sci. 57 (1935) 373.

Leeuwenia indicus TAKAHASHI (nec Bagnall), Iconogr. Insect. Japon. (1932) 1888.

Food plant.—*Lithocarpus* sp.

Habitats.—Hori, Suisha.

Found on the lower sides of the leaves.

LEEUWENIA TAIWANENSIS sp. nov.

Female.—Black; first antennal segment somewhat brownish black, second yellow, blackish especially on basal half, third pale yellow, slightly deeper in color on distal widened part, fourth and fifth similar in color to third, but deeper in color on distal part, sixth pale yellow, darker and shaded with pale gray on

distal part, seventh yellow, dusky on distal half, eighth somewhat yellowish dusky; femora black; fore tibiæ blackish yellow except on distal yellow part, middle and hind tibiæ black except on distal one-third or one-fourth, which is yellow; tarsi yellow, dusky on distal half; bladders blackish yellow; wings pale brown; setæ on head dusky, but those on posterior angles of abdominal segments pale yellowish.

Head including frontal produced part about 1.4 times as long as wide, straight and parallel on sides, very slightly narrowed at base, not constricted behind and across eyes, distinctly but only a little notched behind eyes; cheeks lacking granules and warts, nearly twice as long as eyes, with about seven to ten short spinelike setæ which are about 0.023 mm long, irregularly arranged except on about basal third; vertical reticulations reaching a little behind posterior ocelli, but not postocellar setæ; postocular bristles short, about 0.042 mm long, pointed, distinctly apart from cheeks, a little nearer to cheeks than to the eyes, not reaching eyes; postocellar setæ short, about 0.025 mm long, thin, slightly curved, reaching posterior ocelli, a little nearer to eyes than to ocelli, some small dorsal setæ present except on posterior part. Eyes not protruding, narrower than vertex, nearly parallel on mesal margins, but slightly diverging anteriorly. Ocelli nearly equidistant, anterior ocellus directed forward, nearly reaching bases of antennæ; posterior ocelli in contact with eyes, a little smaller in diameter than distance between themselves, just anterior to a line drawn across the middle of eyes. Mouth parts reaching slightly beyond middle of prothorax, pointed. Antennæ rather slender, first segment wider than long, second much longer than wide, cylindrical, third widely but shallowly indented at middle of mesal side, third to sixth clavate, gradually widened distally, seventh gradually narrowed on basal part, slightly so at apex, eighth not narrowed basally, lengths (and widths) of segments about as follows: III, 0.134 mm (0.042 mm), IV, 0.125 (0.046); V, 0.125 (0.042); VI, 0.115 (0.042); VII, 0.078 (0.032); VIII, 0.051 (0.018). Pronotum much shorter than head, not well reticulated, about 1.8 times as wide as long, with many small setæ, and very stout antero- and postangular bristles and a lateral similar bristle at about middle, the bristles subequal in length, pointed, very slightly narrowed basally, rather short, about 0.048 mm long, usually

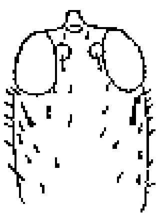

FIG. 4. *Leeuwenia [illegible]* sp. nov.; head.

very slightly curved on distal part; two short thin setæ near anterior margin, much longer than other dorsal setæ, much smaller than angular bristles, and much nearer to angular bristles than to each other. Pterothorax somewhat wider than abdomen, metanotum reticulated on median area of posterior half. Fore coxæ with a very stout seta similar to, but slightly shorter than, angular bristles of pronotum. Abdomen broadest at base, gradually tapering; first tergite triangular, wider than long, second distinctly reticulated on median area, second to eighth transversely reticulated and with many setæ in a group on lateral area, and some small setæ on the median area; postangular setæ of segments stout, pointed, very slightly narrowed basally, stouter than curved dorsal setæ, erect, much shorter than segments, outer ones on seventh segment about 0.096 mm long, dorsal setæ on lateral area of second about 0.03 mm long; tube long, but much shorter than remaining part of abdomen, as long as second to fourth segments taken together, broadest at base, a little tapering, eight times as long as wide at base, not swollen, slightly constricted at apex, sparsely beset with many thin setæ, which are directed posteriorly, slightly curved, as long as width of apex of tube, none on basal and distal small parts, about ten of them discernible along side. Wings nearly reaching seventh abdominal segment, broad, lacking fringe on small basal part of anterior margin, and on shorter distance of hind margin, with no double-fringed hairs. Fore femora stout, twice as long as wide, not reticulated, as long as tibiæ, with many short setæ, and two or three very long setæ near base; middle and hind femora with a very long seta near base; fore tibiæ about 3.8 times as long as wide, with a much longer seta on the distal part; tarsi large, lacking teeth; claws distinct. Body about 4.5 mm, head about 0.369 mm long, 0.268 mm wide, antenna about 0.748 mm long, pronotum about 0.254 mm long, 0.438 mm wide, pterothorax about 0.646 mm wide, first abdominal tergite about 0.231 mm wide, tube about 0.9 mm long, 0.115 mm wide at base, 0.051 mm wide at apex, fore femur about 0.277 mm long, fore tibia about 0.29 mm long.

Food plant.—Unknown.

Habitat.—Raisha.

Three specimens were taken by Dr. Y. Miwa, June 26, 1935, on a decayed tree. This species differs from all known members of the genus in the shorter tube. The most closely related form is *Leeuwenia pugnatrix* Priesner, which is easily distin-

guished from the present new species by the shape of the head and the longer tube. This species is strongly sclerotized, not becoming pale even when treated with caustic potash, but becomes clear when soaked in Schulz's mixture. The type specimens are in the collection of the Department of Agriculture, Research Institute, Formosa.

ECACANTHOTHRIPS MATSUMURAI Ishida.

Ecacanthothrips matsumurai ISHIDA, Insecta Mats., Sapporo 8 (1933) 149.

Habitat.—Taihoku.

The food habit is unknown.

ECACANTHOTHRIPS SANGUINEUS Bagnall.

Ecacanthothrips sanguineus BAGNALL, Trans. Nat. Hist. Soc. Northumberland, n. ser. 3 (1908) 535 (not available); BAGNALL, Ann. Soc. Ent. Belg. 52 (1908) 348; KARNY, Suppl. Ent. 2 (1913) 130; MOULTON, Ann. Zool. Jap. 11 (1928) 322; RAMAKRISHNA AYYAR, Mem. Dept. Agr. India, Ent. Ser. 10 (1928) 274; PRIESNER, Treubia 11 (1930) 361; ISHIDA, Insecta Mats., Sapporo 8 (1933) 148; HOOD, Stylops 4 (1935) 195.

Habitats.—Koshun, Kosen (formerly Kosempo).

The food habit is unknown.

ECACANTHOTHRIPS COXALIS Bagnall var. FORMOSENSIS var. nov.

Male.—Black; antennæ dark, with a yellowish brown tinge, third and fourth segments paler on middle area of outer side, fifth and sixth segments slightly paler on basal half; sense cones dark on third, but transparent on other segments; wings hyaline, slightly pale brownish on distal part, with a median gray line not reaching apex, which is obsolete about middle; femora black; fore tibiæ yellow, blackish along both sides, middle and hind tibiæ black, yellow on small distal part; tarsi pale yellowish, dusky on the apex; setæ dusky, but those on hind angles of abdominal segments pale yellowish; capitate setæ pale apically. Head including the frontal produced part 1.7 times as long as wide, about twice as long as prothorax, twice as long as tube, very slightly convex on cheeks, very slightly narrowed near base, broadest across about middle of cheeks; cheeks over twice as long as eyes, without warts, but with three stout pointed setæ which are shorter anteriorly and about 0.014 to 0.023 mm long; frontal produced part indented at apex; lateral postocular setæ stout capitate, approximately on cheeks, a little longer than setæ on the cheeks, not reaching eyes, about 0.032 mm long; mesal postocular setæ very long, stiff, eminently capitate, di-

rected anterolaterally, reaching beyond a line drawn across middle of eyes, laterad of eyes, slightly longer than eyes, as far apart from eyes as from cheeks, about 0.115 mm long. Eyes not protruding. Antennæ about 1.8 times as long as head; first segment wider than long; second longer than first, constricted basally; third much narrowed on basal part, asymmetrical, more rounded on outer side, striate on basal third, with fourteen sense cones in a single ring on distal part, and some long curved bristles; fourth striate on basal half, with four sense cones; fifth very slightly striate on basal part, slightly constricted on distal part, with two sense cones; sixth similar to, but smaller than, fifth, not striate; seventh with a sense cone; eighth pointed apically, with a very long apical seta; bristles on third and fourth stouter than those on other segments; lengths (and widths) of segments about as follows: III, 0.115 mm (0.06 mm; 0.016 mm at basal part); IV, 0.115 (0.051; 0.018 at base); V, 0.115 (0.037); VI, 0.083 (0.028); VII, 0.065 (0.023); VIII, 0.046 (0.014). Pronotum much wider than long, narrowed anteriorly on anterior half, somewhat constricted behind middle, with a median black line not reaching margins; anterior angular setæ stout, capitate, 0.058 mm long; lateral postangular setæ similar to, but slightly longer than, anterior ones, 0.065 mm long; mesal postangular setæ much longer; midlateral setæ much shorter than anterior angular ones. Fore coxæ scarcely protruding beyond pterothorax, with two very stout pointed setæ equal in length, and a much shorter similar one, longer ones shorter than angular setæ on pronotum, about 0.037 to 0.04 mm long. Pterothorax a little wider than long, on anterior part nearly as wide as posterior margin of prothorax including coxæ, a little narrowed posteriorly. Abdomen broadest at base; first tergite triangular, as long as wide, rounded at corners; postangular bristles of abdominal segments stiff, capitate, as long as, or shorter than, segments, but those on ninth segment as long as tube, bristles on seventh segment about 0.129 mm long; tube stout, tapering, not swollen, twice as long as wide at base, base twice as wide as apex; apical long setæ longer than tube. Wings narrow. Fore femora stout, about twice as long as wide, broadly rounded on lateral side, with a long fine seta on basal part, and a distinct tooth at about middle and also at end; teeth pointed, longer than wide, distal one conical, expanded towards base, slightly shorter, but more sharply pointed than basal one; middle femora thrice as long as wide, with two long, stout, cap-

itate setæ on anterior margin, which are about 0.037 to 0.042 mm long; hind femora about four times as long as wide, with three long, stout, capitate setæ and a few shorter pointed ones in a row on anterior margin; these capitate setæ slightly curved; fore tibiæ shorter than femora, 4.5 times as long as wide, with a very small rounded tubercle on basal part and one or two similar ones on distal part, which are wider than long, one or two very short indistinct teeth also discernible on middle part and a long fine seta on distal part; fore tarsi with an eminent tooth, which is pointed, distinctly longer than wide, slightly indented on mesal side, expanded basally, very slightly rounded on lateral side, and slightly shorter than width of tarsi. Body about 2.15 mm, antenna about 0.65 mm, sense cone on third antennal segment about 0.037 mm long, head including frontal produced part about 0.369 mm long, 0.203 mm wide across eyes, 0.102 mm wide in front of eyes, 0.217 mm wide across cheeks, eyes 0.102 mm long, pronotum 0.346 mm wide at hind end, mesothorax about 0.425 mm wide, tube 0.185 mm long, 0.092 mm wide at the base, longer apical setæ 0.22 mm long, hind wing 0.046 mm wide, fore femur 0.323 mm long, basal tubercle 0.03 mm long, tarsal tooth 0.032 mm long.

Habitat.—Heito.

A single specimen was taken on a decayed branch of *Artocarpus*, March, 1935, by Mr. R. Yamaho. The food habit is not known. Differs from the typical form of *Ecacanthothrips coxalis* Bagnall in the following characters: The third and fourth antennal segments paler on the middle of the lateral part, the fourth and fifth not distinctly paler at the base. Fore femora narrower, twice as long as wide. Setæ on the pronotum longer. Tooth on the fore tarsi very slightly indented on the mesal margin, expanded basally. Middle and hind femora with eminent capitate setæ. The type specimen is in the collection of the Department of Agriculture Research Institute, Formosa.

GIGANTOTHRIPS CRAWFORDI Hood.

> *Gigantothrips crawfordi* HOOD, Insec. Inscit. Menst. 7 (1919) 71.
> *Gigantothrips elegans* TAKAHASHI (nec Zimmerman), Bot. & Zool. Tokyo 2 (1934) 1829.

Food plants.—*Ficus nervosa*, *F. wightiana*, *F.* sp.

Habitats.—Taihoku, Shinten, Hakumo near Tosei, Hori, Shirin near Taihoku.

Sometimes occurs in large numbers on the lower sides of the leaves. Does not form galls. Previously known from the Philippines.

GIGANTOTHRIPS VENAPENNIS Moulton.

Gigantothrips venapennis MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 321.

Food plant.—Unknown.
Habitat.—Kagi.

MEGATHRIPINÆ

ELAPHROTHRIPS FALCATUS Karny.

Elaphrothrips falcatus KARNY, Ent. Runds. 29 (1912) 150; MOULTON, Ann. Zool. Jap. 11 (1928) 322; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1888; PRIESNER, Rev. Zool. Bot. Africa. 22 (1932) 330.
Dicaiothrips falcatus PRIESNER, Boll. Lab. Zool. Portici 21 (1927) 80.

Habitats.—Kagi, Shinten.

Found on the stems and branches of *Artocarpus integrifolia*, *Sterculia nobilis*, and *Psidium guajava*.

ELAPHROTHRIPS FORMOSANUS (Karny).

Idolothrips formosanus KARNY, Suppl. Ent. 2 (1913) 130; MOULTON, Ann. Zool. Jap. 11 (1928) 336.
Elaphrothrips formosanus PRIESNER, Konowia 13 (1934) 193; 14 (1935) 64.

Food plant.—Unknown.
Habitat.—Takao.

MACHATOTHRIPS ARTOCARPI Moulton.

Machatothrips artocarpi MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 322; TAKAHASHI, Iconogr. Insect. Japon. (1932) 1889; PRIESNER, Rev. Zool. Bot. Africa 22 (1932) 344.

Habitats.—Kagi, Heito, Kuraru.

Found on the stem of *Artocarpus integrifolia* and under the bark of decayed trees.

MACHATOTHRIPS CELOSIÆ Moulton.

Machatothrips celosiæ MOULTON, Trans. Nat. Hist. Soc. Formosa 18 (1928) 326; PRIESNER, Rev. Zool. Bot. Africa 22 (1932) 344.

Food plant.—*Celosia argentea*.
Habitat.—Kagi.

PHOXOTHRIPS PUGITOR Karny.

Phoxothrips pugilor KARNY, Suppl. Ent. 2 (1913) 132; MOULTON, Ann. Zool. Jap. 11 (1928) 337.

Food plant.—Unknown.
Habitat.—Koshun.

RHÆBOTHRIPS LATIVENTRIS Karny.

Rhæbothrips lativentris KARNY, Suppl. Ent. 2 (1913) 129; Acta Soc. Ent. Czech. 17 (1920) 42; Archiv f. Zool. 17 (1924) 12; MOULTON, Ann. Zool. Jap. 11 (1928) 337; PRIESNER, Philip. Journ. Sci. 57 (1935) 370.

Food plant.—*Gossypium indicum.*

Habitats.—Taihoku, Kagi, Anpin.

Found in the cotton bolls in Formosa, though taken on *Cassia occidentalis* at Koronya, Ponape Island (Japanese South Sea Islands).

Machatothrips ipomoeæ Ishida [4] may be identical with this species.

[4] Insecta Mats. 7 (1932) 12.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Tæniothrips araliæ* sp. nov.; head of adult female.

2. *Smerinthothrips liliaceæ* Moulton; gall.

3. *Smerinthothrips kuwanai* (Moulton); galls on *Piper futokadsura*.

4. *Leeuwenia taiwanensis* sp. nov.; head.

THE NASUTE TERMITES OF THE PHILIPPINES

By S. F. LIGHT and F. J. WILSON

Of the University of California, Berkeley

TWENTY-SIX TEXT FIGURES

PHILIPPINE NASUTE TERMITES

Genus *Lacessititermes* Holmgren.

1. *Lacessititermes palawanensis* Light.
2. *Lacessititermes holmgreni* sp. nov.

Genus *Hospitalitermes* Holmgren.

3. *Hospitalitermes luzonensis* (Oshima).

Genus *Grallatotermes* Holmgren.

4. *Grallatotermes admirabilis* Light.
5. *Grallatotermes splendidus* sp. nov.

Genus *Nasutitermes* Banks.

Subgenus *Havilanditermes* Light.

6. *Nasutitermes atripennis* (Haviland).

Subgenus *Nasutitermes* sen. str.

7. *Nasutitermes gracilis* (Oshima).
8. *Nasutitermes mollis* sp. nov.
9. *Nasutitermes luzonicus* (Oshima).
10. *Nasutitermes simulans* sp. nov.
11. *Nasutitermes latus* sp. nov.
12. *Nasutitermes panayensis* (Oshima).
13. *Nasutitermes meridianus* sp. nov.
14. *Nasutitermes oshimai* sp. nov.
15. *Nasutitermes chapmani* sp. nov.
16. *Nasutitermes parvus* sp. nov.
17. *Nasutitermes rotundus* sp. nov.
18. *Nasutitermes balintauacensis* (Oshima).
19. *Nasutitermes taylori* sp. nov.
20. *Nasutitermes castaneus* (Oshima).
21. *Nasutitermes mcgregori* (Oshima).
22. *Nasutitermes constricticeps* sp. nov.
23. *Nasutitermes busuangæ* sp. nov.
24. *Nasutitermes brevicornis* sp. nov.

Genus *Subulitermes* Holmgren.

25. *Subulitermes mariveles* sp. nov.
26. *Subulitermes mindanensis* sp. nov.

INTRODUCTION

Forty-eight species of termites have been reported from the Philippines, two by Hagen (1858), one by Haviland (1898),

thirty by Oshima (1914, 1916, 1917, 1920), and fifteen by Light (1921, 1929, 1930). Previous reductions to synonymy (Light, 1930) decreased that total to thirty-nine (Light, 1930, with the addition of *Neotermes grandis* Light, which was omitted from the list). Of these thirty-nine species sixteen are nasute, thirteen of them recorded by Oshima (1914, 1916, 1917, 1920) and three by Light (1930). Oshima's *Eutermes minutus* (1917) was reduced by Light (1930) on the basis of Oshima's statement that this was a manuscript name replaced by *N. gracilis*, which appeared by mistake.

Of these thirteen nasute species of Oshima six are reduced to synonymy in this paper, as follows:

- *Eutermes (Hospitalitermes) hospitalis* (Haviland) Oshima, 1920, to *Hospitalitermes luzonensis* (Oshima).
- *Eutermes (Hospitalitermes) saraiensis* Oshima, 1916, to *Hospitalitermes luzonensis* (Oshima).
- *Eutermes (Eutermes) las-piñasensis* Oshima, 1920, to *Nasutitermes (Nasutitermes) luzonicus* (Oshima).
- *Eutermes (Eutermes) manilensis* Oshima, 1916, to *Nasutitermes (Nasutitermes) luzonicus* (Oshima).
- *Eutermes (Trinervitermes) menadoensis* Oshima, 1920, to *Nasutitermes (Nasutitermes) luzonicus* (Oshima).
- *Eutermes (Rotunditermes) culasiensis* Oshima, 1920, to *Nasutitermes (Nasutitermes) gracilis* (Oshima).

Sixteen new species are described, however, which makes a total of forty-nine species of termites known to occur in the Philippine Archipelago to date, of which twenty-six are nasutes, as listed at the head of this paper.

The material studied by Oshima included a small collection from Dr. C. F. Baker made in the vicinity of the College of Agriculture at Los Baños, Laguna Province, Luzon, and several collections made by R. C. McGregor in various parts of the Archipelago. The named collections of Doctor Oshima, formerly in the Government Institute of Science, Taihoku, Formosa, were briefly studied there by the senior author in 1922. They were removed when Doctor Oshima returned to Japan (fide T. Shiraki). It is extremely unfortunate that Oshima's types were not available for study at this time, since, judging from conditions of preservation in 1922, they are destined to rapid deterioration. Furthermore, Oshima designated neither a holotype nor a type collection, and our observations indicated that the various collections labeled as belonging to a single species often actually represented two or more species. Autotype specimens of a few

species have been available during this investigation. These were kindly sent by Doctor Oshima at Mr. McGregor's request when the senior author first began the study of Philippine termites. Many of Oshima's nasute species were not represented in this material nor is the exact type status of this material known in all cases. Incomplete as it is, it has nevertheless been of the greatest value in settling certain difficult questions.

In spite of this paucity of authentic comparative material, all but one of Oshima's thirteen species of nasutes have been accounted for. Six have been found to be synonymous with other species described by Oshima and present in our collections. The remaining six occur in our collections and have been identified and redescribed. The single species yet to be redescribed is *Nasutitermes mcgregori* Oshima. Oshima's descriptions in general are not sufficiently definite or complete as regards diagnostic specific characters to allow for ready identification of his species, but this one unrevised species seems more than usually definite and has been incorporated on the basis of characters given in Oshima's descriptions and figures.

MATERIAL STUDIED

Extensive collections representing approximately 370 colonies were used in this study. Numerous persons have contributed to these collections, among whom must be mentioned Mr. R. C. McGregor, of the Philippine Bureau of Science, and Dr. E. H. Taylor, formerly of the Bureau of Science, now in the University of Kansas.

Numerous species are represented in the collection by but one or two colonies, a condition which indicates the necessity for careful collecting in the less-frequented regions. Such collecting may be expected to yield unknown species and to increase the known range of those here reported. These new species are to be expected chiefly in the mountainous areas, particularly in the southern islands of the Philippines. The species characteristic of the lowland faunas in various parts of the Islands are undoubtedly reported here. The two dominant species, as will be seen by referring to the lists of collections, are *Nasutitermes luzonicus* (Oshima) and *N. panayensis* (Oshima). *Nasutitermes luzonicus*, the common black-headed Philippine nasute, while occurring throughout the Archipelago, is common only in the northern portion of its range, especially in Luzon, where it is the common nasute and one of the commonest termites. *Nasutiter-*

mes panayensis, the common brown-headed Philippine nasute, is the dominant nasute species throughout the Visayas and one of the commonest elements of the termite fauna there.

METHODS

Descriptions have been restricted to brief diagnoses involving characters expected to be of value in specific differentiation. No attempt has been made to describe workers, since these are not satisfactory for specific differentiation in the present state of our knowledge. Illustrations have been confined to line drawings, chiefly of the head, which bring out such diagnostic characters as dorsal profile, shape, length, and position of the rostrum in the case of the soldiers; and size of eyes and ocelli and the distances separating them in the alates. In addition the left mandible of the soldiers is illustrated for the species of *Nasutitermes* sen. str. as adding useful characters to the relatively meager set available for differentiating species in this difficult group.

TYPES

It is the practice among systematic students of the termites to choose a type colony, one individual of which is separated as the holotype, other members of which are known as paratypes, as are the members of other colonies of the same species investigated. We have followed this procedure, designating the type colony by its number in the collection of the senior author. Holotypes have been deposited in the United States National Museum save in the case of monotypic species, the types of which are retained in the collection of the senior author. Paratypes are retained in the senior author's collection; and, where available, paratypes have been deposited in the collection of Prof. A. E. Emerson, of the University of Chicago. Type collections, as complete as possible, are also to be deposited in the Philippine Bureau of Science, Manila, and in the museum of the California Academy of Sciences, in San Francisco.

TERMS AND MEASUREMENTS

The measurements and indices used in this paper are in general the same as those used in other papers of the senior author. Some, however, are new, devised to facilitate description of the characters of the nasute soldier. The dimensions and indices used are defined in the succeeding paragraphs.

Head measurements for the alate are all made with the head flat and with the dorsal side up. "Length of head of alate" (fig. 1, *on*) is measured from tip of labrum to posterior margin

of head. "Length of head capsule of alate" (fig. 1, *mn*) is here measured from the middle of the anterior end of the capsule to the center of the posterior margin of the head. "Width of head capsule of alate" (fig. 1, *rs*) is measured just behind the eyes. "Width of head with eyes" (fig. 1, *pq*) is width through centers of eyes. "Length of pronotum" is measured at the middle (from notch to notch if present) and "width of pronotum" is maximum width. Eye and ocellus measurements are made with the head turned so as to avoid foreshortening.

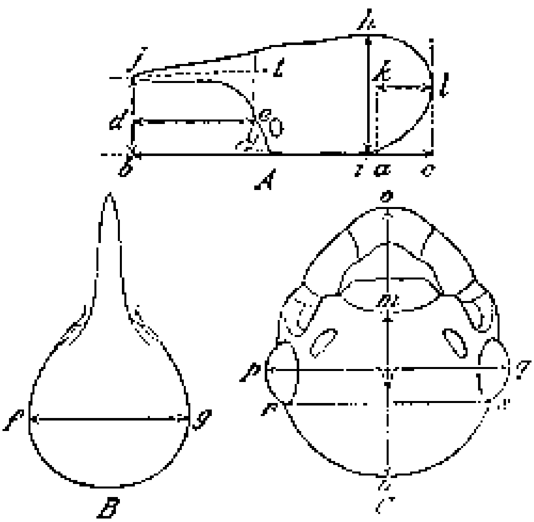

FIG. 1. *Nasutitermes taylori* sp. nov., outline drawings of head of alate and of soldier, to illustrate the dimensions used; *A*, head of soldier in lateral view; *B*, head of soldier in dorsal view; *C*, head of alate in dorsal view; *a*, junction of head and neck; *bc*, length of head with rostrum; *de*, length of rostrum; *fg*, width of head; *hi*, height of head; *kl*, head production; *mn*, length of head capsule of alate; *on*, length of head over all; *pq*, width of head of alate through the eyes; *rs*, width of head of alate behind the eyes.

All measurements for the head of the nasute, except head width, are measured with the head in side view, and with the sagittal plane horizontal. "Length of head with rostrum" (fig. 1, *bc*) is measured in side view with the ventral surface of the head parallel to the scale. "Length of rostrum" (fig. 1, *de*) is measured parallel to the base line with the head, in the same position as for length of head with rostrum, from the innermost point of the front of the head below the base of the rostrum to a line from the tip of the rostrum perpendicular to the base line. This value is less than the actual length of the rostrum, therefore, when the rostrum is either elevated or depressed (fig. 1, *jl*). "Head length without rostrum" is, of course, the difference between the last two measurements. "Head production" is the horizontal extension (fig. 1, *ac*) of the head behind the posterior articulation of neck with head (fig. 1, *a*). "Head width" is measured at the widest point across the dorsal surface. "Head index" is obtained by dividing head width by head length

without rostrum; "head-rostrum index," by dividing rostrum length by head length without rostrum; "head production index," by dividing head production by head length; and "leg elongation index," by dividing length of fore tibia by length of head without rostrum.

All extensively used indices have been arrived at, it will be seen, by dividing the particular dimension by head length without rostrum. Others are defined where first used.

The subgroups of nasute termites of the genus *Eutermes* Hagen (now *Nasutitermes* Banks) defined by Holmgren (1911, 1913) as subgenera are variously used by different authors, as subgenera and genera. Awaiting a much-needed revision to determine their proper status, it seems wise to follow the custom. Thus, we have here used them as genera in this paper following the lead set in the earlier papers of the senior author on Philippine termites (1930) and that of Kemner (1934), although in the senior author's studies of American termites he has followed the lead of Emerson and Snyder and considered them as subgenera (1930).

Soldiers of the smaller species show certain characters that suggest the possibility that they may belong to one or the other of the subgenera briefly differentiated by Holmgren (1911). The fact that the postclypeus is short in the workers of all save *N. mindanensis* sp. nov. and *N. mariveles* sp. nov. and in the alates where present makes it impossible to place these save in *Nasutitermes* sen. str. This holds for the species variously placed by Oshima in *Grallatotermes*, *Rotunditermes*, *Ceylonitermes*, and *Trinervitermes*.

Nasutitermes mindanensis, certainly, and *N. mariveles*, somewhat doubtfully, belong to *Subulitermes*, as indicated by the longer swollen postclypeus of the worker and the lack (*S. mindanensis*) or vestigial nature (*S. mariveles*) of the free apical portion of the soldier mandible. We have followed Kemner in considering *Subulitermes* a separate genus, although the differences seem more nearly of subgeneric value.

Key to the genera of nasute termites found in the Philippine Islands.

ALATES.

1. Smaller, head with eyes less than 1.60 mm wide; pronotum light save in smaller species.
   Subulitermes Holmgren; *Nasutitermes*, subgenus *Nasutitermes* s. s.
   Larger, head with eyes more than 1.70 mm wide; pronotum dark ...... 2.
2. Antennal segment III slightly, if at all, longer than II.................... 3.
   Antennal segment III markedly longer than II.................................. 4.

3. Wings yellow-brown; eyes very large and prominent; pronotum with central notch in posterior margin................ *Grallatotermes* Holmgren.
   Wings black-brown; eyes medium in size; pronotum without notch in posterior margin......., *Nasutitermes*, subgenus *Havilanditermes* Light.
4. Antennal segment III twice as long as II; wing membrane unpigmented. *Hospitalitermes* Holmgren.
   Antennal segment III about one and one-half times as long as II; wing membrane pigmented, brown .... *Lacessititermes* Holmgren.

SOLDIERS

1. Head greatly produced behind and greatly depressed, dorsal profile strongly concave (figs. 2, *c*; 4, *c*; 6, *b*)... 4.
   Head not usually greatly produced, never strongly depressed (fig. 8, *c*); when produced, head narrow and constricted (fig. 22, *a*)... ... . 2.
2. Antennæ short, median segment less than twice as long as broad, or when antennæ are long, head constricted (fig. 22, *a*)........................ 3.
   Antennæ elongated, head not constricted (figs. 7, *a*). *Nasutitermes*, subgenus *Havilanditermes* Light.
3. Free apical portion of mandible lacking or vestigial; postclypeus of worker swollen, about half as long as wide. *Subulitermes* Holmgren.
   Free apical portion of mandible well developed; postclypeus of worker not especially swollen, less than half as long as wide. *Nasutitermes*, subgenus *Nasutitermes* sen. str.
4. Rostrum short and thick; legs only moderately elongated, hind femora considerably short of end of abdomen........ *Grallatotermes* Holmgren.
   Rostrum long or shorter and very slender; legs greatly elongated, hind femora longer than abdomen.. 5.
5. Rostrum long, relatively thick at base; antennal segment III shorter than IV .... *Lacessititermes* Holmgren.
   Rostrum short and slender; antennal segment III longer than IV. *Hospitalitermes* Holmgren.

Genus LACESSITITERMES Holmgren

Key to the two Philippine species of Lacessititermes.

ALATES

1. Pronotum with deeply notched posterior margin; fontanel more than half as wide as ocellus.. *L. holmgreni* sp. nov.
   Posterior margin of pronotum entire; fontanel very narrow, slitlike. *L. palawanensis* Light.

SOLDIERS

1. Head short, head-rostrum index about 0.70; apical fourth of rostrum red or yellowish.. *L. holmgreni* sp. nov.
   Head long, head-rostrum index about 0.50; rostrum without well-marked apical area.. *L. palawanensis* Light.

1. LACESSITITERMES PALAWANENSIS Light. Text fig. 2.

Lacessititermes palawanensis LIGHT, 1930.

Dealate (*young queen*).—Generally dark brown; head black-brown, postclypeus light brown, antennæ yellow, pronotum rusty

yellow-brown. Ocelli (fig. 2, *a*) separated from eyes by more than their long diameter but less than twice their short diameter; width between eyes 1.22 mm; head width through eyes 1.80 mm. Fontanel (fig. 2, *a*) narrow, slitlike; region about fontanel only slightly sunken. Posterior margin of pronotum entire (fig. 2, *a*); mesonotum and metanotum roundly excavated, corners rounded.

Soldier (*fig. 2, b and c*).—Head black-brown; nota, tergites, and first segment of antennæ dark smoky brown; coxæ, femora, and region of head about antennæ rusty brown; tibiæ, tarsi, and distal halves of antennæ very light yellow-brown; rostrum of same color as head or with an indistinct paler apical region; rostrum relatively slender. Segment II of antennæ distinctly shorter than III (fig. 2, *b*); head without hairs or with one or two hairs near posterior; head length 1.75 to 1.85 mm, head width about 1 mm; head relatively short; head-rostrum index about 0.70. All abdominal tergites with a posterior row of stiff hairs.

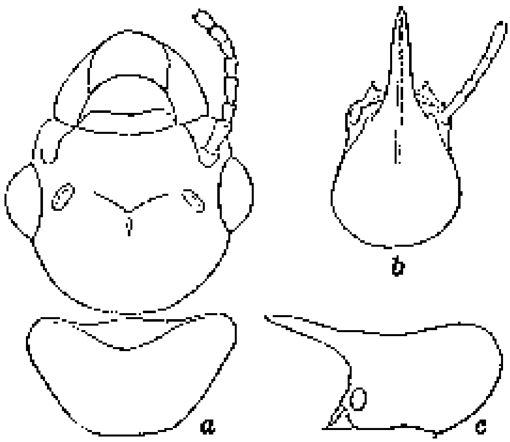

FIG. 2. *Lacessititermes palawanensis* Light; *a*, head and pronotum of alate in dorsal view; *b* and *c*, head of soldier in dorsal and lateral views, respectively.

Measurements in millimeters of a queen of Lacessititermes palawanensis Light.

Length of head	2.16
Length of head capsule	1.50
Width of head through eyes	1.83
Long diameter of ocellus	0.20
Length of fontanel	0.11
Diameter of eye	0.45
Distance between inner margins of eyes	1.43
Length of antennal segment I	0.24
Length of antennal segment II	0.15
Length of antennal segment III	0.22
Length of pronotum	0.81
Width of pronotum	0.50

Measurements in millimeters of a soldier of Lacessititermes palawanensis Light.

Length of head	1.62
Length of rostrum	0.57
Width of head	1.02
Width of pronotum	0.58
Length of pronotum	0.26
Length of hind tibia	2.15
Head-rostrum index	0.50

Biology and distribution.—The single colony was taken in 1923 by Dr. E. H. Taylor on Thumb Peak near Iwabig, Palawan. He reported the species as occurring to an elevation of above 4,500 feet and building small, very light, paper nests in small shrubs or rattan. He also reports that there were no covered runways above or below the nest, which would mean that the species is a forager, as its long legs and dark color would indicate.

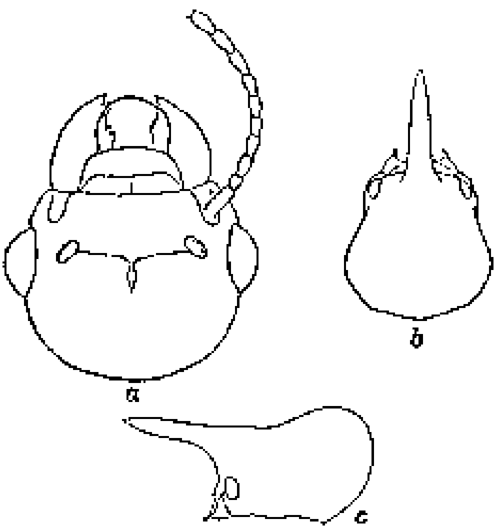

FIG. 3. *Lacessititermes holmgreni* sp. nov.; *a*, head of alate in dorsal view; *b* and *c*, head of soldier in dorsal and lateral views, respectively.

2. LACESSITITERMES HOLMGRENI sp. nov. Text fig. 3.

Alate (*fig. 3, a*).—Generally dark brown; head black-brown; postclypeus yellow-brown; antennæ light yellow-brown; pronotum dark brown, lighter behind. Ocelli separated from eyes by about their long diameter; width between the eyes 1.50 mm, width of head through the eyes 2.08 mm. Fontanel large, lancet-shaped, in a strongly sunken area. Posterior margin of pronotum deeply notched; mesonotum and metanotum roundly excavated, the corners angular.

Soldier (*fig. 3, b and c*).—Head black; nota and tergites dark brown; antennæ, lateral thoracic segments, and coxæ brown; femora yellow-brown; tibiæ and tarsi lighter; rostrum relatively short, with apical reddish area. Segments II and III of antennæ subequal. Head without hairs or with one or two posterior

hairs; head length about 1.80 mm, head width about 1 mm. All abdominal tergites with a single posterior row of stiff hairs.

DESCRIPTIONS

Alate.—Head dark mahogany brown; postclypeus, antennæ, and legs yellow-brown; labrum very light yellow-brown; pronotum brown, lighter posteriorly; mesonotum and metanotum anteriorly ivory brown, darker posteriorly; tergites dark brown; sternites brown, centrally slightly paler; wing membrane light brown, radius sector deep brown, costal margin brown, subcostal stripe nearly as wide as radius sector, brown with yellow cast.

Head shaped as in fig. 3, *a;* central region of head about fontanel markedly sunken.

Fontanel (fig. 3, *a*) lancet-shaped, more than half as wide as ocellus and slightly longer, flaring anteriorly to form lateral points, which continue to the ocelli as faint lines.

Ocellus (fig. 3, *a*) elliptical, long diameter about one-third that of eye; separated from eye by the long diameter of ocellus.

Eye projecting, large, separated from lower margin of head by about one-fifth its own diameter, from upper margin of head by about one-half its own diameter, and from posterior margin by somewhat more than its own diameter; width of head between eyes 1.35 mm.

Antennæ of about the same color throughout, segment II much shorter than III.

Measurements in millimeters of a typical alate of Lacessititermes holmgreni sp. nov., from the type collection, No. 1712.

Length over all	16.01
Length of forewing	14.17
Width of forewing	3.86
Length of head	2.16
Length of head capsule	1.50
Width of head capsule	1.57
Width of head with eyes	1.87
Length of pronotum	0.844
Width of pronotum	1.54
Diameter of eye	0.55
Long diameter of ocellus	0.20
Short diameter of ocellus	0.16

Soldier.—Head and rostrum deep black-brown shading into mahogany brown at base; distal one-fourth to one-fifth of ros-

trum reddish; nota and tergites dark brown; antennæ, lateral thoracic sclerites, and coxæ brown; tibiæ and tarsi somewhat lighter.

Head and rostrum shaped as in fig. 3, *b* and *c*; rostrum elevated, with a slight hump near its base; rostrum basally thick, tapering throughout, about 0.2 mm thick at middle.

Antennæ twice as long as head with rostrum, same color throughout; segments VII and VIII longest, distal segments decreasing in length; segment III shorter than or nearly as long as IV.

Measurements in millimeters, and indices, of a typical soldier of Lacessititermes holmgreni sp. nov., from the type collection, No. 1712.

Length of head and rostrum	1.80
Length of head without rostrum	1.06
Length of rostrum	0.72
Head production	0.27
Height of head	0.96
Width of head	1.14
Length of fore tibia	1.32
Head index	0.90
Head-rostrum index	0.68
Head production index	0.23
Leg elongation index	1.15

Biology and distribution.—Three collections were made by A. C. Duyag, in May and June, 1934, all from Dinagat, Dinagat Island, Surigao Province, just north of the northernmost point of Mindanao. All contained queens and one contained alates. Nothing is known of their biology, but they are almost certainly carton-nest builders.

Systematic position.—The alate of this species differs from all save that of *L. palawanensis* in the combination of large head size with ocelli removed from the eyes by about their long diameter. The first form reproductive differs from that of *L. palawanensis*, which otherwise it resembles very closely, in the larger fontanel and the notched posterior margin of the pronotum.

The soldier keys out to *L. ransoneti* Holmgren in Holmgren's key (1913). From this species it differs, however, in being larger with much thicker and somewhat longer rostrum. From *L. palawanensis* Light the nasute differs markedly in its much longer, thicker rostrum with a red tip.

Genus HOSPITALITERMES Holmgren

3. HOSPITALITERMES LUZONENSIS Oshima. Text fig. 4.

? *Eutermes (Hospitalitermes) saraiensis* OSHIMA, 1916.
Eutermes (Hospitalitermes) luzonensis OSHIMA, 1917.
? *Eutermes (Hospitalitermes) hospitalis* OSHIMA, 1916, 1920.

Alate.—Head posteriorly brownish black, anteriorly brown; postclypeus same color as head; labrum light brown; antennæ light brownish yellow; pronotum dark brown, bordered laterally with very light yellowish brown; mesonotum and metanotum light brown; tergites dark brown; sternites brown, centrally pale; wing membrane pale whitish with faint yellowish tinge, almost unpigmented save for dark brown radius sector and light brown costal margin.

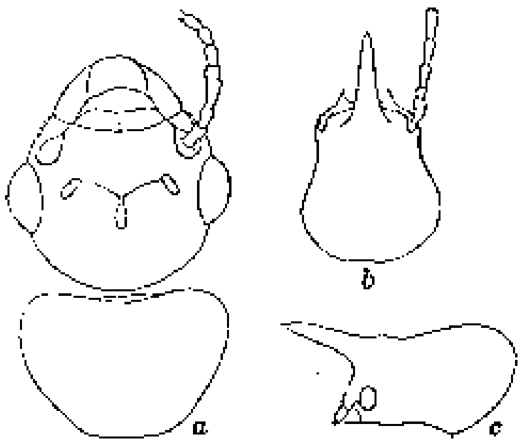

FIG. 4. *Hospitalitermes luzonensis* Oshima: a, head and pronotum of alate in dorsal view; b and c, head of soldier in dorsal and lateral views, respectively.

Head shaped as in fig. 4, *a*; broad behind, frontal region constricted; eyes wide apart, protruding.

Fontanel (fig. 4, *a*) smoothly elliptical, about equal to ocellus in length but narrower than ocellus, located just posterior to a line joining posterior margins of ocelli, in a ridge which separates two lateral sunken areas; frons sunken, especially so immediately in front of fontanel.

Ocelli elliptical, more than one-half as wide as long, nearly vertical in position; separated from eye by at least short diameter of ocellus.

Eye separated from lower margin of head by about one-fifth, from upper margin of head by nearly one-half, and from posterior margin by slightly more than, its own diameter.

Antennæ somewhat elongated, decreasing in width distally, of fifteen or sixteen segments; where fifteen, III much the longest, at least twice as long as II; where sixteen, II and IV subequal, III larger.

Pronotum (fig. 4, *a*) long, considerably longer than one-half its width, broadest near anterior end; anterior margin somewhat uplifted at center, nearly straight but with median emargination; anterolateral corners rounded; sides nearly straight, strongly receding, rounding very broadly into narrow, slightly convex, posterior margin; posterior region of pronotum depressed. Mesonotum and metanotum angularly excavate behind, metanotum deeply so.

Wings heavily haired but without other ornamentation; hairs evenly distributed on membrane; median and cubitus and its branches marked by close-set lines of hairs set off by clear zones on either side; median near cubitus; cubitus with six unbranched basal branches, the first five relatively heavily pigmented, the sixth with some pigment distally; distal branches of cubitus from three to six, unpigmented, one or more branched. No costal stripe, usual dark zone behind radius sector narrower than vein.

Measurements in millimeters of an alate of Hospitalitermes luzonensis Oshima, from collection 728, from Basilan Island.

Length over all	14.35
Length of forewing	12.70
Width of forewing	3.50
Length of head	1.74
Length of head capsule	1.25
Width of head capsule	1.31
Width of head with eyes	1.68
Length of pronotum	0.90
Width of pronotum	1.45
Diameter of eye	0.45
Long diameter of ocellus	0.19
Short diameter of ocellus	0.12

Soldier (*fig. 4, b and c*).—Head black to dark mahogany brown behind, lighter anteriorly, distal half of rostrum lighter when head is darkly pigmented. Antennæ, nota, tergites, coxæ, and femora dark brown, heavily pigmented. nota darkest; sternites, tibiæ, and tarsi pale.

Head and rostrum shaped as in fig. 4, *b* and *c*. Head enormously produced and remarkably elevated behind; rostrum short, slender, somewhat uplifted; dorsal profile deeply concave.

Antennæ of fourteen segments, greatly elongate, nearly as long as body. Forelegs about as long as antennæ, other legs much longer.

Measurements in millimeters, and indices, of a soldier of Hospitalitermes luzonensis Oshima, from collection 423, from Basilan Island.

Length of head and rostrum	1.74
Length of head without rostrum	1.20
Length of rostrum	0.54
Head production	0.54
Height of head	0.87
Width of head	1.11
Length of hind tibia	2.10
Head index	0.93
Head-rostrum index	0.45
Head production index	0.45
Leg elongation index	1.60

Systematic position.—Examination of a long series from various parts of the Archipelago indicates the presence of a single, widespread, highly variable species of this genus.

This species agrees with the paratypes of *H. luzonensis* (Oshima), which were available for comparison. No satisfactory differences between this species and *H. saraiensis* and *H. hospitalis* are to be derived from the descriptions. The inference is that there is but the single species of the genus in the Philippines, but until type material of Oshima's *H. saraiensis* is available it seems best to retain the more recent name.

Oshima correctly considered the common Philippine species, his *H. luzonensis*, to be distinct. As brought out in part by the table below it is nearest to *H. hospitalis* (Haviland), but differs from it in that the soldier has paler antennæ, in that the antennæ of *H. luzonensis* are considerably less elongated than those of *H. hospitalis*, and in that the legs are considerably shorter actually and in proportion to the head length than in *H. hospitalis*.

These differences in the soldiers are brought out in the table below, which presents certain characters of the common Malayan and Indian species. The indices recorded were obtained as follows: "Head-rostrum index" by dividing head length by rostrum length (p. 465), "III-index" by dividing the length of antennal segment III by the length of head with rostrum, and "tibial index" by dividing the length of the head with rostrum by the length of hind tibia.

The close agreement in length of head with rostrum in this group of five species is notable as is the great variation in rostrum length within *H. luzonensis* as brought out by a range

in head-rostrum index of from 0.36 to 0.50 in the five specimens whose measurements are presented. This probably represents the extremes, however, for the range in another group of nineteen was only from 0.40 to 0.47. Evidently, however, this index will only be available when range and average are known. III-index seems more diagnostic, since although here there is a range from 0.12 to 0.16 in *H. luzonensis*, indicating considerable variation in length of segment III (as also, of course, in the head length), yet this figure is always less than that found for the single individual of *H. hospitalis* available. The tibial index also presents possibilities for diagnostic purposes.

Comparison of Oriental species of Hospitalitermes Holmgren.

Species.	Source.	Length of head without rostrum.	Length of head.	Length of rostrum.	Head-rostrum index.	Length of antennal segment III.
		mm.	*mm.*	*mm.*		*mm.*
Hospitalitermes hospitalis	Borneo	1.77	1.26	0.51	0.40	0.338
Hospitalitermes luzonensis	Laguna (cotypes)	1.30	1.32	0.48	0.36	0.290
Do.	do.	1.74	1.23	0.51	0.41	0.261
Do.	Ilocos Norte	1.65	1.28	0.59	0.47	0.29
Do.	Mindoro	1.59	1.20	0.60	0.50	0.2175
Do.	do.	1.21	1.19	0.52	0.45	0.232
Hospitalitermes umbrinus	Borneo	1.72	1.195	0.62	0.63	0.345
Hospitalitermes monoceros	Ceylon	1.68	1.22	0.46	0.38	0.244
Do.	do.	1.76	1.33	0.44	0.33	0.226
Hospitalitermes flaviventris	Malacca	1.36	1.13	0.63	0.55	0.223

Species.	Source.	Length of antennal segment IV.	III-index.	Length of tibia.	Tibial index.	Color.
		mm.		*mm.*		
Hospitalitermes hospitalis	Borneo	0.290	0.19	2.64	0.67	Very dark.
Hospitalitermes luzonensis	Laguna (cotypes)	0.2175	0.16	2.46	0.73	Dark.
Do.	do.	0.246	0.15	2.28	0.56	Do.
Do.	Ilocos Norte	0.23	0.16	2.46	0.78	Do.
Do.	Mindoro	0.232	0.12	2.31	0.77	Do.
Do.	do.	0.282	0.136	2.32	0.56	Do.
Hospitalitermes umbrinus	Borneo	0.319	0.20	2.90	0.62	Lighter.
Hospitalitermes monoceros	Ceylon	0.235	0.145	2.52	0.60	Medium.
Do.	do.	0.25	0.15	2.56	0.59	Do.
Hospitalitermes flaviventris	Malacca	0.25	0.14	2.48	0.71	Light.

Distribution.—This species is widespread throughout the Archipelago. The collections in hand range from the northern

end of Luzon to Palawan and the southern end of Mindanao. In Luzon the following provinces are represented: Ilocos Norte, Cagayan, Pangasinan, Pampanga, Bataan, Rizal, Laguna, Cavite, and Tayabas (including Marinduque Island). There are many collections from some of these provinces, and without doubt search would prove the species to be present in all the others. In addition there are collections from Mindanao, Samar, Panay, Cebu, Negros, Palawan, and Basilan Islands, and no doubt the species would be found in all other islands of any size. No other species, save, of course, *Macrotermes gilvus*, the mound builder, and perhaps *Neotermes malatensis*, has so wide a distribution in the Archipelago.

Biology.—This species, like others of the genus studied in Ceylon and elsewhere, is a day forager. Its armies extend for a distance of at least several hundred yards, consisting of five or six lines of workers, flanked by an outer cordon of soldiers. They gather fragments of decayed leaves, possibly of fungus, which are taken to the nest—a large, dark brown to black structure at the base of a tree giving off an unpleasant odor. This species, whose nests are to be found by careful search almost on the outskirts of Manila, offers a remarkable opportunity for a study of social organization, caste determination, feeding methods, behavior, etc.

Genus GRALLATOTERMES Holmgren

This genus, separated as a subgenus by Holmgren (1912) for *Termes grallator* Desneux, seems to consist of relict species—*G. grallator* (Desneux) in New Guinea, *G. grallatoriformis* (Holmgren) in the Anamalai Hills of northern India (1917), *G. weyeri* Kemner (1913) in Amboina, *G. admirabilus* Light (1930) in Negros, Panay, and Mindanao, and *G. splendidus* sp. nov. in the depths of a swamp about Lake Casili, near Arayat, Pampanga. All collections of the Philippine species were from virgin forest, which probably explains their restricted distribution.

Oshima's species assigned to the subgenus *Grallatotermes*, *Eutermes* (*G.*) *brevirostris* from the Caroline Islands (1917) and *Eutermes* (*G.*) *luzonicus* and *E.* (*G.*) *panayensis* from the Philippines, as also Snyder's *N.* (*G.*) *oceanicum* from the Santa Cruz Archipelago, belong to the genus *Nasutitermes*, the *Eutermes* sen. str. of Holmgren.

Key to the soldiers of the two Philippine species of Grallatotermes Holmgren.

1. Head black or black-brown; body, antennæ, and legs light brown. *G. splendidus* sp. nov.

   Head, antennæ, and abdominal tergites dark brown; thorax and legs bright yellow; sternites very pale brown, lateral abdominal membranes white .... *G. admirabilus* Light.

4. GRALLATOTERMES ADMIRABILUS Light. Text fig. 5.

Alate.—Head black, median areas of thoracic sterna, legs, and distal segments of antennæ yellow; other parts light or dark brown; clypeus lighter than frons, about one-fourth as long as broad; segment III of antennæ about as long as II; fontanel white, conspicuous, a three-rayed fissure; ocelli conspicuous, separated from eye by less than their short diameter, eyes very large, strongly projecting; costal stripe inconspicuous.

Measurements in millimeters of alates of Grallatotermes admirabilus Light.

Length with wings, male	18.00
Length with wings, female	19.00–21.00
Body length, male	9.00
Body length, female	10.00
Length of forewing	15.20–16.20
Length of forewing with scale	17.00
Width of head with eyes	1.90
Width of head between eyes	1.08
Length of head	1.80
Head length to clypeofrontal suture	1.20–1.25
Width of postclypeus (maximum)	0.76–0.80
Diameter of compound eye	0.72
Length of ocellus	0.225
Length of fontanel	0.16
Length of pronotum	0.97–1.00
Width of pronotum	1.80

Soldier (*fig. 5*).—Head, antennæ, and abdominal sclerites black-brown with reddish tinge; rostrum distally dark reddish; thorax and legs bright yellow, ventral side of abdomen white to light yellow-brown.

Head and rostrum shaped as in fig. 5, dorsal profile concave and slightly sinuous; rostrum short, thick conical (fig. 5, *b*), uplifted, arising by a very broad base from the otherwise

declivitous frons. Antennæ of thirteen segments, considerably longer than head with rostrum.

Measurements in millimeters of soldiers of Grallatotermes admirabilus Light.

Length	4.50–5.50
Length of head to posterior margin of antennal foveola	1.25
Length of head with rostrum	1.80
Width of head	1.20
Width of pronotum	0.72
Length of pronotum	0.42
Length of hind femur	1.68
Length of hind tibia	2.10

Distribution and biology.—As reported (Light, 1930) this species has been taken once in Panay, twice in Negros, and twice on the Cotabato coast of Mindanao. A large carton nest on a tree trunk was reported in two cases (Panay and Negros). Aside from this, nothing is known of the biology of this striking species.

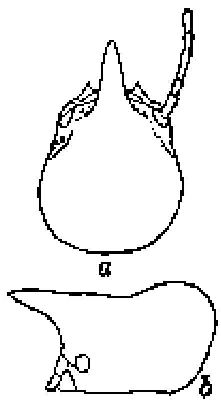

FIG. 5. *Grallatotermes admirabilus* Light, head of soldier: *a*, dorsal view; *b*, lateral view.

5. GRALLATOTERMES SPLENDIDUS sp. nov. Text fig. 6.

Alate.—Unknown.

Soldier (fig. 6).—Head black, with a deep purplish effect, to dark mahogany; anterior half of rostrum reddish; antennæ and pronotum brown; other tergites light brown; sternites and legs brownish yellow.

Head large; head and rostrum shaped as in fig. 6. Rostrum short, thick-based, somewhat elevated; dorsal profile concave but less so than in *G. admirabilus* Light, not sinuous; mandibles thornlike, distal portion bearing a faint vestige of a tooth just below the middle.

Antennæ of thirteen segments, shorter than in *G. admirabilus*, slightly longer than head with rostrum; segment III much elongated, more than twice as long as II; III longer than IV; V to XIII subequal, about one-seventh shorter than III. Body relatively weakly chitinized, abdomen long and relatively slender (not "humped" as in *G. admirabilus*).

Measurements in millimeters, and indices, of a typical soldier of Grallatotermes splendidus sp. nov., from the type collection, No. 238.

Length of head and rostrum	1.95
Length of head without rostrum	1.33
Length of rostrum	0.62
Length of antennal segment III	0.20
Length of antennal segment IV	0.14
Head production	0.27
Height of head	1.00
Width of head	1.41
Length of fore tibia	1.20
Head index	1.06
Head-rostrum index	0.47
Head production index	0.22
Leg elongation index	0.90

Systematic position.—This striking species, known only from soldiers and workers, differs from the four other species of the genus in (*a*) its larger size, (*b*) its shorter antennæ and legs, and (*c*) the elongated, relatively slender abdomen of both soldiers and workers.

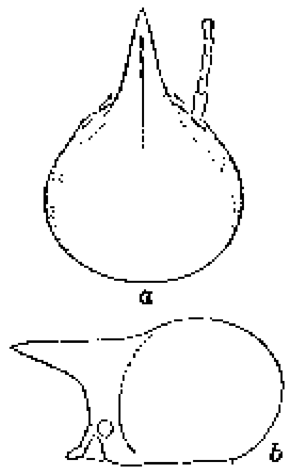

FIG. 6. *Grallatotermes splendidus* sp. nov., head of soldier; *a*, dorsal view; *b*, lateral view.

Distribution and biology.—This species was taken by Light and McGregor from a large carton nest on the rotten stub of a small tree in the swampy jungle near the southwest shore of Lake Casili. This island of undisturbed lowland forest, located just across the Pampanga River from Arayat, Luzon, merits careful study from a faunal, floristic, and ecologic angle. No record was made of covered ways, but the relatively weakly chitinized bodies of workers and soldiers and the relatively short legs make it very improbable that they are day foragers.

Genus NASUTITERMES Banks

Subgenus HAVILANDITERMES Light, 1930

6. NASUTITERMES ATRIPENNIS (Haviland). Text fig. 7.

Alate.—Dark brown; wings brown-black, very thickly haired; postclypeus much shorter than half its width. Fontanel large,

three-cornered. Ocellus separated from eye by its short diameter or more. (Diagnosis based on Holmgren's description of *Eutermes atripennis* Haviland.)

Soldier (fig. 7).—Head light brownish yellow; rostrum darker distally, red-brown; tergites dark brown.

Head and rostrum shaped as in fig. 7; dorsal profile distinctly concave; rostrum long, thick, conical, strongly uplifted. Antennæ of fourteen segments.

Measurements in millimeters of a large and a small soldier of Nasutitermes atripennis (Haviland).

	Large soldier.	Small soldier.
Length of head	5.2	4.3
Length of head to posterior margin of antennal foveola	1.17	1.08
Length of head with rostrum	2.13	2.03
Width of head	1.30	1.12
Length of pronotum	0.27	
Width of pronotum	0.63	
Length of hind tibia	1.80	1.75
Length of abdomen	2.70	2.43

Subgenus NASUTITERMES sen. str. Banks

The species, most of them new, that are here allocated to this subgenus represent several very distinct types, which may ultimately be given subgeneric or generic rank. At present, however, the alates are but little known, and the relations of the species to the other species in the group are not sufficiently well known to allow satisfactory determination of subgeneric characters.

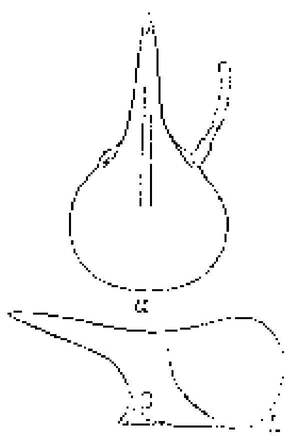

FIG. 7. *Nasutitermes atripennis* (Haviland), head of soldier; *a*, dorsal view; *b*, lateral view.

The differentiation of species in this group presents difficult problems, especially when dependence must be made chiefly on soldier characters. Variation both within the same colony and between colonies is very great. Until very large collections are available, which will permit a determination of the nature, extent, and significance of intraspecific variation, the classification of these species must remain unsatisfactory and to some extent tentative. Oftentimes, however, the decisions are actually more justified than can be brought out by

any method of description as yet available. A certain intangible facies sets certain lots apart as a single species in spite of relatively great variation in size, in head shape, etc., and even in proportions. Such differences are brought out by the figures of *Nasutitermes gracilis* Oshima (fig. 8).

Key to the soldiers of the Philippine species of Nasutitermes Banks sen. str.

1. Head little produced behind, relatively short; without obvious constriction behind the antennæ (except *N. balintauacensis*) .... 2.
   Head much produced behind, relatively long, pyriform, with a constriction behind the antennæ (fig. 22, *a*) .... 15.
2. Rostrum conical, at least twice as thick at base as at middle (fig. 10, *b*) .... 3.
   Rostrum awl-shaped (cylindrical), less than twice as thick at base as at middle (fig. 18, *a*) .... 11.
3. Head yellow .... *N. gracilis* (Oshima).
   Head black, infuscated brown, or clear brown .... 4.
4. Head black, dark brown, or brown with infuscation; tip of rostrum typically red .... 5.
   Head brown .... 8.
5. Very small, head with rostrum less than 1.30 mm long; dorsal profile of head distinctly convex .... *N. mollis* sp. nov.
   Larger, head with rostrum more than 1.35 mm long (usually much more); head profile flat or sinuous .... 6.
6. Tergites well chitinized, dark brown; rostrum relatively short and thick, head-rostrum index less than 0.60 .... 7.
   Tergites weakly chitinized; pale yellowish brown; head sharply contracted in front; rostrum longer, head-rostrum index more than 0.60. *N. luzonicus* (Oshima).
7. Antennal foveolæ not visible in dorsal view; rostrum longer, more slender .... *N. sinuosus* sp. nov.
   Antennal foveolæ visible in dorsal view; rostrum shorter and thicker. *N. latus* sp. nov.
8. Tergites dark brown, strongly pigmented .... *N. pasayensis* (Oshima).
   Tergites pale to yellow .... 9.
9. Larger; head, antennæ, etc., orange-brown .... *N. meridianus* sp. nov.
   Smaller; head light brown; antennæ and tergites light .... 10.
10. Tergites very pale; rostrum relatively narrow (fig. 15, *a* and *b*); from Luzon .... *N. oshimai* sp. nov.
    Tergites yellow; rostrum thick (fig. 16, *b* and *c*); from southern islands .... *N. clapmani* sp. nov.
11. Very small head, with rostrum less than 1.20 mm long; mandible with vestigial apical portion (fig. 17, *c*) .... *N. parvus* sp. nov.
    Large head, with rostrum more than 1.30 mm long; free apical portion of mandible relatively long and spinelike .... 12.
12. Larger; head with rostrum more than 1.60 mm long; head very broad, head index 1.05 or more; apical portion of mandible strongly outcurved (fig. 18, *c*) .... *N. rotundus* sp. nov.

Smaller; head with rostrum less than 1.55 mm long; head narrower, head index only slightly over 1.00; apical portion of mandible not strongly outcurved .... 13.

13. Anterolateral margins of head in dorsal view indented by slight but distinct constriction (fig. 19, *a*)........... *N. balintauacensis* (Oshima).

No such indentation .... 14.

14. Head dark smoky brown, particularly at base of rostrum; tergites smoky brown; rostral hump very conspicuous (fig. 20, *c*). *N. taylori* sp. nov.

Head light brown; tergites light yellow-brown; rostral hump not conspicuous .... *N. castaneus* (Oshima).

15. Rostrum long, head-rostrum index more than 0.70. *N. megregori* (Oshima).

Rostrum short, head-rostrum index less than 0.50........................ 16.

16. Head brown, rostrum very dark at base, tergites dark, strongly chitinized; constriction very conspicuous (fig. 22, *a*). *N. constricticeps* sp. nov.

Head orange to orange-brown; rostrum not darkened, at most reddish; tergites pale yellow or light brown, not strongly chitinized; constriction not very conspicuous .... 17.

17. Constriction conspicuous; anteroventral corners of head capsule flaring (fig. 23, *a*); mandible with oblique sides, apical portion about one-third as long as basal portion (fig. 23, *c*). *N. busuanga* sp. nov.

Constriction inconspicuous; anteroventral corners of head capsule not visible from above (fig. 24, *a*); mandible with nearly straight lateral side, its apical portion nearly as long as basal portion (fig. 24, *c*). *N. brevicornis* sp. nov.

7. NASUTITERMES GRACILIS (Oshima). Text fig. 8.

Eutermes (*Eutermes*) *gracilis* OSHIMA, 1916, 1920.
Eutermes minutus OSHIMA, 1917 (fide Oshima).
Eutermes (*Rotunditermes*) *calasiensis* OSHIMA, 1920.

Dealate (*fig. 8, a*).—Head brown, postclypeus and labrum pale yellow; antennae light brown; pronotum brownish yellow; mesonotum pale yellowish white; metanotum pale yellow; thorax white with lines bordering sclerites; tergites chestnut-brown; sternites yellow to golden yellow with lateral brown areas around white muscle marks; head small, 1.25 mm wide through eyes; shaped as in fig. 8, *a*.

Fontanel conspicuous (fig. 8, *a*), whitish yellow, Y-shaped, flaring anteriorly; slightly longer than ocellus.

Ocellus elliptical, long diameter less than one-third diameter of eye; separated from eye by about one-half the short diameter of ocellus.

Eye large, projecting (fig. 8, *a*); separated from both upper and lower margin of head by about one-eighth its own diameter

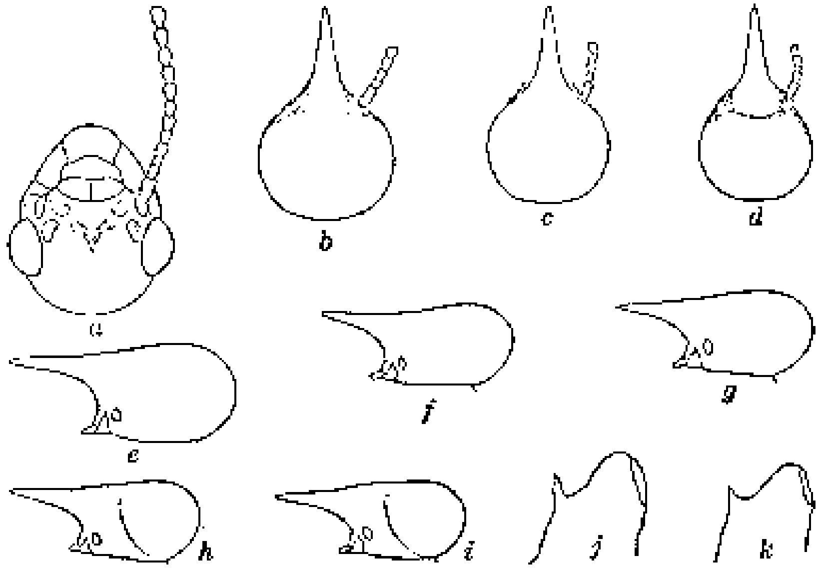

FIG. 8. *Nasutitermes gracilis* (Oshima); *a*, head of alate from Ilocos Norte in dorsal view; *b* to *d*, heads of soldiers in dorsal view to show variation (*b* from Palawan, *c* from Rizal, *d* from Ilocos Norte from same colony as *a*); *e* to *i*, heads of soldiers in lateral view to show variation (*e* from Mount Mariveles, Bataan; *f* from Panay; *g* from Mindanao; *h* from Ilocos Norte; *i* from Rizal); *j* and *k*, left mandibles of soldiers (*j* from Cotabato, the typical form; *k* from Panay, an extreme variant, probably abnormal).

and from posterior margin by about three-fifths its own diameter.

Antennæ of twelve or more segments, III shortest and narrowest, about one-half as wide as distal segments, weakly chitinized; V small or incompletely separated from VI; II and IV relatively short, subequal, wider than III or V (when separate), but narrower than more distal segments.

Measurements in millimeters of a dealate of Nasutitermes gracilis (Oshima), from collection 1236, from Palawan.

Length of body with head	5.98
Length of head	1.45
Length of head capsule	1.03
Width of head capsule	0.93
Width of head with eyes	1.25
Length of pronotum	0.61
Width of pronotum	0.64
Diameter of eye	0.49
Long diameter of ocellus	0.17
Short diameter of ocellus	0.13
Distance of ocellus from eye	0.03

Soldier (*fig. 8, b to k*).—Head yellow to orange; antennæ pale yellow-brown; distal two-thirds of rostrum reddish; body generally pale and slightly chitinized; tergites pale yellow-brown.

Head somewhat variable in shape (fig. 8, *b* to *i*), but about as broad as long with flattened or flatly rounded posterior border; rostrum long and narrow, especially in distal half; rostral hump absent (fig. 8, *f*) or negligible, lateral profile straight (fig. 8, *c*), faintly concave (fig. 8, *f*), or weakly sinuous (fig. 8, *h*); head typically depressed anteriorly and roundly elevated behind.

Mandible (fig. 8, *j* and *k*) different from that of soldiers of the *matangensis* group in its relatively small free portion and its distally extended molar region.

Measurements in millimeters, and indices, of extreme sizes of soldiers of Nasutitermes gracilis (Oshima), from collection 665, from Mount Mariveles, Bataan Province, Luzon.

Length of head and rostrum	1.74	1.68
Length of head without rostrum	1.09	1.05
Length of rostrum	0.65	0.63
Head production	0.30	0.30
Height of head	0.76	0.72
Width of head	1.20	1.10
Length of hind tibia	0.83	0.78
Head index	1.10	1.09
Head-rostrum index	0.60	0.60
Head production index	0.28	0.29

Variation.—This is a very widespread, variable species. So considerable was the variation in size and degree of coloration, accompanied in some cases by seeming differences in the shape of mandible of the soldier, that there were originally set aside three new species. Study of variations within groups showed that the characters used in separating these supposed species did not always hold in single collections. It has seemed wiser, therefore, to leave any finer taxonomic distinctions to later workers to whom more material is available.

The range of size is brought out by fig. 8, *b* to *i*, and by the measurements of soldiers from several colonies given below.

Certain colonies from the lower slopes of Mount Mariveles, Bataan Province, Luzon, have considerably darker color, the head being golden yellow to light orange with red rostrum. Here also the tergites are fairly well chitinized and light brown. These colonies are correspondingly larger (see measurements

below of soldier from collection 685), however, and there seems to be a direct correlation between size and color.

At the other extreme are small forms from Ilocos Norte (No. 1275), Rizal (No. 141), and Palawan (No. 122), measurements of soldiers of which are given below, which are much lighter in color and chitinization than are the soldiers of most of the colonies, and have narrower, somewhat square heads. However, changes in these directions with decreasing size seem characteristic of the nasutes of several species, and hence these differences have been disregarded here, especially since more typical colonies of *N. gracilis* have been found in all these localities.

Measurements of soldiers in millimeters, and indices, from various colonies of Nasutitermes gracilis (Oshima).

	Province.					
	Laguna.	Bataan.	Ilocos Norte.	Rizal.	Palawan.	Laguna.
Lot No.	144	670	1275	58	1237	964
Length of head and rostrum ..... mm.	1.49	1.56	1.43	1.54	1.44	1.61
Length of head without rostrum ..... mm.	0.99	0.91	0.84	0.96	0.93	1.05
Length of rostrum ..... mm.	0.58	0.65	0.59	0.58	0.54	0.55
Head production ..... mm.	0.25	0.30	0.25	0.24	0.27	.....
Height of head ..... mm.	0.56	0.67	0.51	0.69	0.60	.....
Width of head ..... mm.	0.96	0.93	0.84	1.02	0.93	.....
Length of fore tibia ..... mm.	0.75	0.69	0.60	0.69	0.72	.....
Head index	1.06	0.99	1.00	1.06	1.03	0.96
Head-rostrum index	0.65	0.71	0.70	0.61	0.63	0.51
Head production index	0.29	0.33	0.29	0.25	0.31	0.23
Leg elongation index	0.83	0.76	0.71	0.72	0.79	0.73

Systematic position.—This is the only Philippine nasute whose soldier has a yellow head and a conical rostrum. It seems most closely related to *N. javanicus* (Holmgren), but is distinctly larger.

Distribution and biology.—This is one of the common species, occurring twenty times in the collection from localities as far apart as Ilocos Norte Province, Luzon, on the one hand, and Sir J. Brooke Point, in southern Palawan, and Cotabato Province, Mindanao, on the other. Other regions represented are Rizal, Bataan, Laguna, and Tayabas Provinces in Luzon, Tablas Island, and Culasi in Antique Province, Panay. It is especially abundant on the slopes of Mounts Mariveles and Maquiling.

Nasutitermes gracilis builds extensive covered ways, over dead wood of trees and shrubs and even over deserted buildings. Taylor reported an exposed carton nest for a colony taken on Tablas Island and a subterranean carton nest for one taken at 300 meters' altitude on Mount Maquiling.

8. **NASUTITERMES MOLLIS** sp. nov. Text fig. 9.

Alate.—Unknown.

Soldier.—Head smoky yellow-brown behind; darker along sides and in front; rostrum proximally burnt umber, distally reddish; abdominal tergites pale smoky brown; nota pale yellow with faint smoky tinge; other parts pale whitish yellow. Head and rostrum shaped as in fig. 9, *a* and *b*; dorsal profile distinctly convex, with a concavity at base of rostrum due to a slight constriction. Head covered with a dense coat of slender whitish hairs. Antennæ of eleven segments, about two-thirds length of head with rostrum.

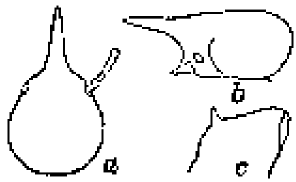

FIG. 9. *Nasutitermes mollis* sp. nov., soldier; a, head in dorsal view; b, head in lateral view; c, left mandible.

Measurements in millimeters, and indices, of typical soldiers of Nasutitermes mollis sp. nov., from the type collection, No. 1131, from Cotabato Province, Mindanao.

Length of head and rostrum	1.23	1.23	1.32
Length of head without rostrum	0.78	0.75	0.81
Length of rostrum	0.45	0.44	0.48
Head production	0.23	0.22	0.24
Height of head	0.45	0.43	0.51
Width of head	0.74	0.72	0.81
Length of tibia	0.54	0.48	0.54
Head index	0.95	0.96	1.00
Head-rostrum index	0.58	0.64	0.59
Head production index	0.26	0.29	0.27
Leg elongation index	0.69	0.64	0.67

Distribution and biology.—The single collection (No. 1131) was taken by E. H. Taylor "in a dead tree" on Luan River, Cotabato Province, Mindanao.

Systematic position.—The minute size and small number of antennal segments associated with the heavy hairing of the head and the relatively long, narrowly conical rostrum set this species apart from all other Oriental species of this genus.

9. NASUTITERMES LUZONICUS (Oshima). Text fig. 10.

Eutermes (Grallatotermes) luzonicus OSHIMA, 1914, 1916, 1920.
Eutermes (Eutermes) manilensis OSHIMA, 1916.
Eutermes (Eutermes) los-piñasensis OSHIMA, 1920.
? *Eutermes (Trinervitermes) mercedesensis* OSHIMA, 1920.

This is the most widespread and the most commonly encountered of the nasute termites of the Philippines. It seems

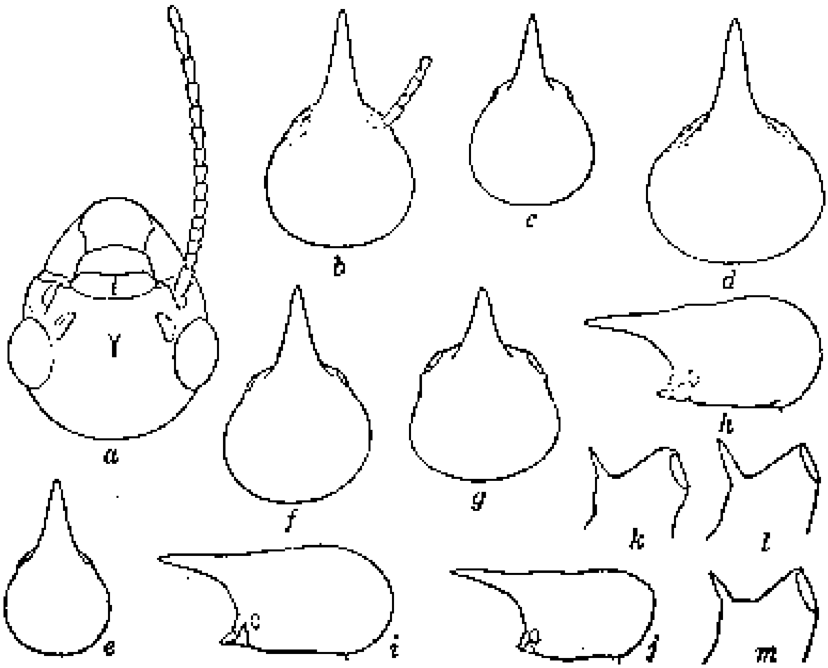

FIG. 10. *Nasutitermes luzonicus* (Oshima): *a*, head of alate in dorsal view; *b* to *g*, heads of soldiers in dorsal view to show variation in size and proportions (*e* to *g*, individuals from the same colony, No. 153, from Rizal; *g* is probably abnormal); *h* to *j*, heads of soldiers in lateral view to demonstrate variations in dorsal profile and size of rostrum; *k* to *m*, left mandibles of soldiers to illustrate variations.

also to be the most variable, perhaps due to the large collections available for study. There follows an attempt at a diagnosis of the alate and soldier. These should be considered in the light of the wide variation discussed below. The description of the alate is somewhat more detailed as it has not been previously described.

Alate (*fig. 10, a*).—About 8 mm long without wings, 15 mm with wings; forewing about 14 mm long. Head dark mahogany

brown, nota yellowish, abdominal tergites brown; abdominal sternites yellow with lateral brown areas, wings pale yellowish brown, veins light brown, radius sector bordered posteriorly by a narrow dark brown stripe separated by a narrow white stripe from a golden zone, which shades into the membrane color.

Head (fig. 10, *a*) about 1.5 mm wide through the eyes, not greatly narrowed in front. Eyes relatively large, about 0.55 mm in long diameter, but not strongly projecting. Ocellus about one-third as long as eye, separated from eye by about half its short diameter; long axis of ocellus making an angle of about 45° with the long axis of head; short axis of ocellus nearly vertical, making chitin of head seem to overlie its inner margin. Head with curved, raised, transverse ridge joining ocelli, succeeded posteriorly by a distinct concavity within the anterior half of which the slender, slitlike, yellowish to white fontanel is located in a narrow longitudinal ridge. Antennæ of fifteen segments; segments II and III subequal in length. Pronotum faintly concave posteriorly. Diagnosis based on collection 706 from Cavite.

Measurements in millimeters of a typical alate of Nasutitermes luzonicus (Oshima), from collection 706, from Cavite, Luzon.

Length over all	15.40
Length of forewing	14.00
Width of forewing	3.60
Length of head	1.80
Length of head capsule	1.11
Width of head capsule	1.14
Width of head with eyes	1.50
Length of pronotum	0.70
Width of pronotum	1.25
Long diameter of eye	0.55
Short diameter of eye	0.45
Long diameter of ocellus	0.20
Short diameter of ocellus	0.14
Distance of ocellus from eye	0.06

Soldier (*fig. 10, b to m*).—Head mahogany red (brown in fixative) to black; distal half of rostrum usually reddish, but black in some colonies; antennæ light brown; body weakly chitinized; tergites pale yellow-brown to light brown, depending upon degree of chitinization.

Head variable in shape as brought out under variation, but with certain underlying characteristics; head relatively broad (fig. 10, *b*), sides rounded; posterior margin flatly rounded;

head distinctly narrowed in front, its sides in dorsal view rounding into the sides of the rostrum. Dorsal profile as seen in lateral view typically sinuous (fig. 10, *h*); a shallow groove, marking morphological junction of head and rostrum, running from front of head just above mandibles obliquely upward and backward, passing in front of antennæ and crossing head some distance behind the level of the antennal foveolæ, where it makes a slight concavity; a slightly raised area between this concavity, in dorsal profile, and the front of the head (the "rostral hump," fig. 10, *h*); rostrum constricted near its base, making a weak concavity between rostral hump and dorsal margin of free portion of rostrum (fig. 10, *j*); dorsal margin of rostrum usually weakly convex, due to slightly uplifted position of free portion as a whole and slight depression of distal third of free portion.

Antennæ of thirteen segments, nearly as long as head with rostrum; segment IV shortest, III nearly twice as long as II.

Measurements in millimeters, and indices, of typical soldiers of Nasutitermes luzonicus (Oshima).

	No. 706.	Paratype.
Length of head and rostrum	1.74	1.66
Length of head without rostrum	1.14	0.99
Length of rostrum	0.60	0.57
Head production	0.3	0.30
Height of head	0.82	0.66
Width of head	1.17	1.02
Head index	1.02	0.99
Head-rostrum index	0.53	0.57
Head production index	0.28	0.30

Worker.—Head dark brown; tergites pale.

Distribution and variation.—*Nasutitermes luzonicus* is by far the commonest and most widespread nasute termite of the Philippines and perhaps the commonest termite species. We have 188 collections of the species, including one from Itbayat Island in the Batanes, north of Luzon, nearer to Formosa than to Luzon, and one from Sitankai Island, in the southernmost Tawitawi group, within a few miles of northern Borneo. The others are from many of the islands and provinces between. It is most abundant in Luzon, where it is the only abundant nasute species, yet it has been taken on all the principal islands, save Palawan; namely, Mindoro, Samar, Panay, Negros, Cebu, Leyte, and on several of the smaller ones, as Marinduque, Romblon, Tablas, Dinagat, Basilan, and Jolo. In the Visayas it is more or less

completely replaced as the common nasute species by the light brown *N. panayensis* (Oshima) described below.

The soldiers of *N. luzonicus* show an extremely wide variation, as is brought out by fig. 10, *b* to *g*. So great is this variation that with incomplete collections it would be natural, as the senior author's earlier manuscripts attest, to describe these variants as separate species, as Oshima has done. When, however, one finds the extremes of such variation within a single colony, as is often the case, it becomes apparent that it is of no taxonomic significance.

So extreme is this variation that it becomes almost impossible to diagnose the species. Were it not that this is the only common dark-headed species of *Nasutitermes* and, indeed, the only one save *N. mollis*, *N. simulans*, and *N. latus*, which are smaller and known only from Mindanao and Palawan, its identification would be extremely difficult.

This variation affects size, color of head, degree of chitinization, and color of abdominal sclerites, and especially the relative width of head and the shape and relative length of rostrum. Collections from certain colonies seem consistently black headed, but some contain dark- and lighter-headed individuals, while in others all are lighter headed. In dark individuals the reddish coloration of the distal portion of the rostrum tends to be obscured. In very light individuals the distal portion of the rostrum is yellowish, rather than red.

The head length with rostrum ranges from somewhat less than 1.4 mm (fig. 10, *d*) to slightly more than 1.8 (fig. 10, *c*). When this shorter length is combined, as is usually the case, with a narrower head (fig. 10, *c*) the size difference is striking. The smallest individuals are as a rule lighter and have fewer (12) antennal segments. This suggests that we are dealing here with soldiers which metamorphosed in an earlier instar. Intergrades complicate the situation, which must wait for solution upon careful studies of the life cycle and the developing colony. The University of the Philippines, situated in the center of abundance of the species, is well located for such a study.

The range in size and in relative width of head is illustrated in fig. 10, *b* to *f*. Head width in the individuals measured ranges from 0.78 to 1.26 mm and the index obtained by dividing head width by head length with rostrum varies from 0.48 to 0.73. It is interesting to note that the maximum spread for this index was found by measuring the extremes of variation

within a single colony (fig. 10, *e* and *f*). In spite of the great differences in this index between extreme variants, the index is nearly always between 0.60 and 0.65 for what may be called the typical soldiers (fig. 10, *b*), which make up by far the larger part of most collections.

While, therefore, there is a very striking range of variation in head size and proportions, the ordinary soldiers present a fairly constant shape and size of head, represented in fig. 10, *b* and *i*. Furthermore, while in some cases the variation seems to be between colonies, in those collections which are fair samples it is found to be intracolonial. Thus, in colony 113, from Balintawac near Manila, four individuals were selected that ranged from 1.38 to 1.68 in length of head with rostrum, from 0.78 to 1.10 mm in width of head, and from 0.48 to 0.73 in ratio of width of head to length of head with rostrum. It should be said, however, that the individual with the ratio of 0.73 was plainly abnormal (fig. 10, *g*) as brought out by the blunt, rough rostrum, the peculiarly broad front of the head, and other features. Another soldier in the same collection, apparently normal, had an index of 0.68.

Not only does the head vary in size, shape, and proportions as seen in dorsal view, but the profile in lateral view shows much variation (fig. 10, *h* to *j*). This involves several factors; namely, (*a*) the relative height of the head itself in front and behind (fig. 10, *h* and *j*), (*b*) the relative prominence of the rostral hump (fig. 10, *h* and *i*), and (*c*) the direction of the rostrum, whether slightly uplifted as a whole (fig. 10, *j*), depressed (fig. 10, *h*), or neither (fig. 10, *i*). The rostral hump gives the characteristic sinuous appearance to the profile of this species. The profile becomes distinctly convex when the hump is inconspicuous and the rostrum straight or uplifted (fig. 10, *i*).

Finally, the rostrum itself varies in relation to the head length, in its thickness throughout or at the base, and in its shape. In the more typical individuals the sides of the head curve into the rostrum in dorsal view and the rostrum beyond the base is clearly narrowed, giving it concave sides in dorsal view (fig. 10, *b*) and a concave lower margin in lateral view (fig. 10, *i*). Certain individuals, however, show a much-narrowed, slender rostrum (fig. 10, *j*). In others this basal constriction is lacking, giving the rostrum a coarser appearance, its margins in dorsal view being nearly straight lines (fig. 10, *c*), the concavity of the ventral margin being very slight. Again,

the rostrum varies as to the distal portion, in some being straight, but more commonly somewhat bent down as in fig. 10, *h*, or bent up as in fig. 10, *j*. Much of the apparent variation in length of rostrum is due to the fact that a thick rostrum looks shorter in either dorsal or lateral view.

Systematic position.—Its range, from within sight of Formosa to within sight of Borneo, would suggest that this species would prove to be the same as a Formosan or Bornean species. That it would prove to be cospecific with a Formosan termite seems unlikely, because of the depth between the Batanes and Formosa and the correlated wide differences in their faunæ and floræ. It differs from *N. takasugoensis*, also a member of the *matangensis* group, which it approaches most closely among the Formosan species, in its much larger alate and in the much more narrowed rostrum.

Nasutitermes luzonicus will probably be found in Borneo, but it has not been identified with any East Indian species. From both *N. matangensis* (Holmgren) and *N. matangensiformis* (Holmgren) it differs in the typically much narrower head and rostrum of the soldier and its much darker color.

Biology.—The conspicuous brown carton nests of this species, built usually on trees, are a characteristic element of the rural or village scene in Luzon. Its rather broad light brown to black-brown runways, constructed of wood fragments and fæces, connect the nests with the ground and with the dead wood on which it feeds. Runways are occasionally found on houses, and rarely it attacks the wood of houses, usually when, as on the outskirts of Manila, for example, the clearing away of trees has reduced the amount of available natural wood.

That the secretions of the cephalic glands furnish a fairly effective defense against true ants seems indicated by the reaction of ants into whose opened nests, or near the openings of whose nests, soldiers and workers were thrown. Workers are sometimes carried away by ants, but soldiers almost never; and ants exhibit signs of disturbance, seemingly of fear apparently induced by an odor from the termites. Ants that do pick up termites seem distressed by secretions, as indicated by vigorous wiping of their mandibles.

10. NASUTITERMES SIMULANS sp. nov. Text fig. 11.

Alate.—Unknown.

Soldier.—Head chestnut, lightest at level of antennæ; proximal half of rostrum dark smoky brown, distal half lighter, somewhat reddish; tergites, including nota, smoky brown; sternites very pale yellow-brown; lateral membranes transparent white; antennæ light brown; other parts pale yellow.

Head and rostrum shaped as in fig. 11, *a* to *d*. Rostral hump prominent with a slight constriction at its base; head considerably narrowed in front; antennal foveolæ not visible in dorsal view; head with three or four prominent hairs.

Antennæ of thirteen segments, rather less than length of head with rostrum; segment III much longer than II; IV and I about as long as II, not always completely separated.

Abdomen relatively long and slender, not humped.

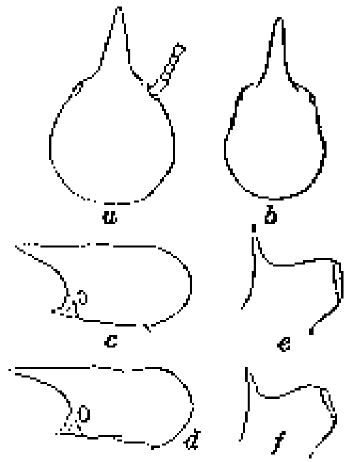

FIG. 11. *Nasutitermes simulans* sp. nov.; *a* and *b*, heads of two soldiers from the same colony, in dorsal view, to show range of variation; *c* and *d*, heads of two soldiers from the same colony, in lateral view, to show range of variation; *e* and *f*, left mandibles of soldiers.

Measurements in millimeters, and indices, of soldiers of Nasutitermes simulans sp. nov., from the type collection, No. 1188, from Cotabato Province, Mindanao.

Length of head and rostrum	1.47	1.39	1.53
Length of head without rostrum	1.02	0.91	0.99
Length of rostrum	0.45	0.49	0.54
Head production	0.30	0.27	0.36
Height of head	0.60	0.60	0.67
Width of head	0.90	0.84	0.99
Length of fore tibia	0.78		0.78
Head index	0.88	0.92	1.00
Head-rostrum index	0.44	0.53	0.55
Head production index	0.29	0.36	0.33
Leg elongation index	0.77	0.76	0.79

Variation.—Color varies from dark opaque chestnut in the large individuals to lighter brown with a yellowish tinge in some

of the smaller ones. Rather wide variation as to width and shape of head in dorsal view, as also in lateral profile and shape of rostrum, is brought out by fig. 11, *a* to *d*.

Systematic position.—*Nasutitermes simulans* is apparently most closely related to *Eutermes (E.) javanicus* Holmgren, but differs from it materially in its larger size and darker color.

Distribution and biology.—The single collection, No. 1183, was made by E. H. Taylor, in "rotten wood" on Malanipa Island, Cotabato Province, Mindanao. Nothing is known of its biology.

11. NASUTITERMES LATUS sp. nov. Text fig. 12.

Alate.—Unknown.

Soldier.—Head chestnut; rostrum proximally dark smoky, distally reddish; antennæ shading from light red at base to yellow at tip; tergites and nota smoky brown, pronotum darkest; sterna very pale brown; other parts yellowish.

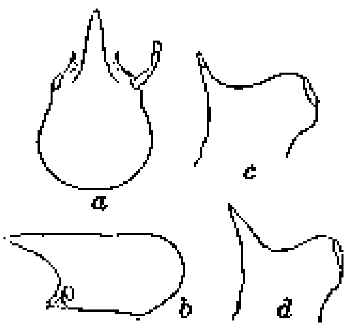

FIG. 12. *Nasutitermes latus* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c* and *d*, left mandibles.

Head and rostrum as in fig. 12, *a* and *b*; rostrum short, blunt, relatively narrow at base; rostral hump low but distinct; head broad at level of antennæ; antennal foveolæ exposed in dorsal view; head with three or four scattered, long, slender hairs.

Antennæ of thirteen segments; segments IV and V shortest, subequal; III longer.

Abdomen relatively short and broad, somewhat humped.

Measurements in millimeters, and indices, of soldiers of Nasutitermes latus sp. nov., from the type collection, No. 1206, from Sir J. Brooke Point, Palawan.

Length of head with rostrum	[illegible]	1.11	1.12
Length of head without rostrum	0.93	0.95	0.93
Length of rostrum	0.46	0.46	0.49
Head production	0.21	0.20	0.19
Height of head	0.61	0.63	0.67
Width of head	0.90	0.91	0.90
Length of femur	0.90	0.90	0.93
Length of hind tibia	1.02	1.08	1.03
Length of fore tibia	0.73	0.73	
Head index	0.97	0.95	0.97
Head-rostrum index	0.65	0.61	0.63
Head production index	0.27		

Systematic position.—*Nasutitermes latus* differs from *N. javanicus* Holmgren in the same way as does *N. simulans* sp. nov. From *N. simulans,* which it resembles in color scheme and general size, it differs most strikingly in its generally broader head, the broad flat anterior portion of head making antennal foveolæ visible in dorsal view (fig. 12, *a*), and in its shorter rostrum. Other differences are the greater height of head, lower rostral hump, and the shorter, thicker abdomen.

Distribution and biology.—The single collection was taken from rotten wood at Sir J. Brooke Point, Palawan, by E. H. Taylor. Nothing else is known of its biology.

13. NASUTITERMES PANAYENSIS (Oshima). Text fig. 13.

Eutermes (Grallatotermes) panayensis OSHIMA, 1920.
Eutermes (Ceylonitermes) megregori OSHIMA, 1920 (not of Oshima, 1916).

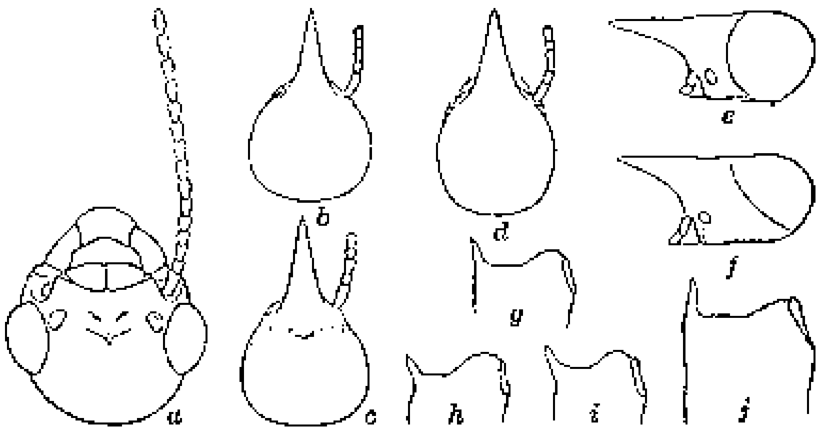

FIG. 13. *Nasutitermes panayensis* (Oshima): *a*, head of alate in dorsal view; *b* to *d*, heads of soldiers in dorsal view (*b* from an autotype from Culasi, Panay; *c* from a specimen from Tibiao, Panay, labeled by Oshima "*Ceylonitermes Megregori*" from which, of course, it differs very widely; *d* from an abnormal soldier with thick rostrum, taken in Negros); *e*, head of typical soldier in lateral view; *f*, head of abnormal soldier (same as *d*) in lateral view; *g* to *j*, left mandibles of soldiers (*j* from abnormal soldier *d* and *f*).

Alate (*fig. 13, a*).—Very similar to *N. luzonicus*. Head consistently lighter, slightly smoky light reddish brown; antennæ yellow-brown, frontal region very light brown; postclypeus light yellow-brown; tergites dark brown, darker than in *N. luzonicus*. Fontanel short, nearly triangular (fig. 13, *a*), much shorter than that of *N. luzonicus*. Otherwise as in *N. luzonicus*.

Measurements in millimeters of a typical alate of Nasutitermes panayensis (Oshima), from collection 167, from Cebu.

Length over all	15.5
Length of forewing	13.0
Width of forewing	3.7
Length of head	1.06
Length of head capsule	1.14
Width of head capsule	1.14
Width of head with eyes	1.50
Length of pronotum	0.84
Width of pronotum	1.32
Long diameter of eye	0.55
Short diameter of eye	0.50
Long diameter of ocellus	0.18
Short diameter of ocellus	0.13
Distance of ocellus from eye	0.04

Soldier (*fig. 13, b to j*).—Head much like typical *N. luzonicus* in shape, but never as wide as in wider individuals of *N. luzonicus*; with similar variations as to head profile. Rostrum somewhat longer, more slender distally, and more pointed. Head consistently light brown; tergites dark smoky brown, darker than head, and darker than tergites of *N. luzonicus*, which are much lighter than head. Left mandible (fig. 13, *g* to *i*) with short free portion; a depression between it and the molar surface shallow; lateral and medial surfaces nearly straight.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes panayensis (Oshima), from collection 167, from Cebu.

Length of head and rostrum	1.59
Length of head without rostrum	1.04
Length of rostrum	0.55
Head production	0.26
Height of head	0.68
Width of head	0.99
Length of fore tibia	0.84
Head index	0.95
Head-rostrum index	0.53
Head production index	0.25
Leg elongation index	0.81

Worker.—Much like *N. luzonicus*, but head lighter, tergites darker; head light brown, tergites smoky brown.

Variation.—Variation is much less noticeable in *N. panayensis* than in *N. luzonicus*. A paratype collection from Oshima, collected by McGregor at Culasi, Panay, shows the greatest range of variation noted, brought out by measurements below. In spite

of differences in size, the indices show the proportions to be very similar.

Measurements in millimeters, and indices, of smallest and largest soldiers of Nasutitermes panayensis (Oshima), in paratype collection 1558, from Culasi, Panay.

Width of head	0.81	0.91
Length of head with rostrum	1.36	1.52
Length of rostrum	0.49	0.57
Length of head capsule	0.87	0.96
Head index with rostrum	0.59	0.60
Head index without rostrum	0.93	0.95+
Rostral index	0.57	0.59

A single soldier in the same vial with a young colony of *N. chapmani* has been referred to this species because of the obvious similarities in many characters; such as, color of head and pigmentation of sclerites. It differs in having a short, basally thickened rostrum (fig. 13, *d* and *f*), which led to its being considered at first as representing a new species. The mandible also is very large with the free portions differently directed (fig. 13, *f*). This apparently aberrant soldier represents the greatest extreme of variation so far encountered if it is normal variation.

Measurements in millimeters, and indices, of an abnormal soldier of Nasutitermes panayensis (Oshima).

Length of head and rostrum	1.56
Length of head without rostrum	1.05
Length of rostrum	0.51
Head production	0.30
Height of head	0.66
Width of head	0.96
Length of fore tibia	0.99
Head index	0.91
Head-rostrum index	0.49
Head production index	0.29
Leg elongation index	0.95

Distribution and biology.—This, the common nasute termite of the Visayas, is represented in the collection by forty vials, which might easily have been four hundred. These collections are from the following islands and provinces: Marinduque Island, Tablas Island, Romblon Island, Panay, Negros, Cebu, Camasa Island, Leyte, and Zamboanga. The species is extremely common on Cebu and Negros Islands, and probably elsewhere, where it presents the same picture as does *N. luzonicus* in Luzon,

being extremely common in and about the cultivated, thickly populated areas. Its brown runways and carton nests are common sights on bamboo, coco palm, mango, and the other common trees of the region; also on fence posts, telephone poles, and houses. However, it seems to differ from its northern counterpart in its propensity to build over houses and attack decaying wood in them.

Systematic position.—*Nasutitermes panayensis* is close to *N. luzonicus* from which it differs chiefly in color of soldier and alate. The head of the soldier is narrower on the average and the rostrum narrower distally and more sharply pointed. The alates of the two species are very close, but that of *N. panayensis* is much lighter and averages somewhat smaller.

13. NASUTITERMES MERIDIANUS sp. nov. Text fig. 14.

Alate (*fig. 14, a*).—Very close to the alate of *N. luzonicus;* pronotum somewhat darker, perhaps; fontanel small, inconspicuous (often variable, however, in *N. luzonicus*). Otherwise as in *N. luzonicus.*

Measurements in millimeters of a typical alate of Nasutitermes meridianus sp. nov., from the type collection, No. 318, from Zamboanga Province, Mindanao.

Length over all	15.2
Length of forewing	13.4
Width of forewing	3.4
Length of head	1.65
Length of head capsule	1.20
Width of head capsule	1.30
Width of head with eyes	1.57
Length of pronotum	0.74
Width of pronotum	1.32
Long diameter of eye	0.56
Short diameter of eye	0.48
Long diameter of ocellus	0.20
Short diameter of ocellus	0.14
Distance of ocellus from eye	0.06

Soldier (*fig. 14, b to i*).—Head orange-brown; rostrum darker at base, distally reddish; antennæ, thorax, and abdominal tergites yellow with brownish tinge; legs yellow.

Head and rostrum shaped as in fig. 14, *b* and *c*. Dorsal profile as in *N. luzonicus;* mandible variable (fig. 14, *f* to *i*), but usually with relatively long free portion; lateral margin slightly oblique; anterior sinus relatively short and deep; molar surface short, succeeded proximally by a short flattened area, beyond which the inner margin is somewhat concave.

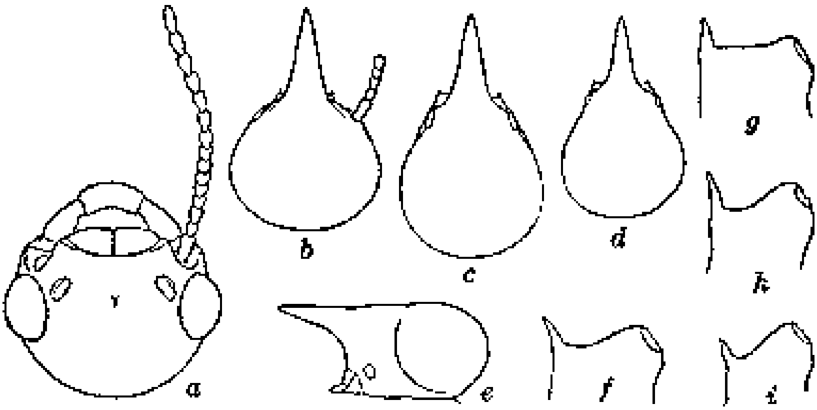

FIG. 14. *Nasutitermes meridianus* sp. nov.: *a*, head of alate in dorsal view; *b* to *d*, heads of soldiers in dorsal view, to show range in size and proportions, all from Palawan; *e*, head of soldier in lateral view; *f* to *i*, left mandibles of soldiers to show variation.

Antennæ of thirteen segments, nearly as long as head with rostrum.

Measurements in millimeters, and indices, of a large soldier of Nasutitermes meridianus sp. nov., from collection 313, from Jolo.

Length of head and rostrum	1.80
Length of head without rostrum	1.14
Length of rostrum	0.66
Head production	0.30
Height of head	0.78
Width of head	1.26
Length of fore tibia	1.14
Head index	1.10
Head-rostrum index	0.56
Head production index	0.26
Leg elongation index	1.00

Measurements in millimeters, and indices, of soldiers of Nasutitermes meridianus sp. nov., with narrower heads than those of the type collection, No. 313.

Length of head and rostrum	1.80	1.71
Length of head without rostrum	1.16	1.05
Length of rostrum	0.64	0.66
Head production	0.33	0.30
Height of head	0.76	0.66
Width of head	1.02	1.08
Length of femur	1.19	1.07
Length of hind tibia	1.33	1.33
Head index	0.95	1.02
Head-rostrum index	0.61	0.63
Head production index	0.30	0.30

Measurements in millimeters, and indices, of soldiers of Nasutitermes meridianus sp. nov., with smaller head capsules and mandibles, from collection 1225, Palawan.

Length of head and rostrum	1.61	1.51
Length of head without rostrum	0.93	0.93
Length of rostrum	0.57	0.58
Head production	0.24	0.24
Height of head	0.58	0.55
Width of head	0.93	0.93
Length of femur	0.78	0.73
Length of hind tibia	1.16	1.07
Length of fore tibia	0.84	0.78
Head index	1.00	1.00
Head-rostrum index	0.62	0.62
Head production index	0.26	0.26

Variation.—Very different head types are encountered in the same collection, illustrated by fig. 14, *b* and *c*. That these are not two soldier classes is indicated, however, by intergrading individuals (fig. 14, *d*).

Systematic position.—*Nasutitermes meridianus* belongs to the *matangensis* group and is one of a group of very closely related Philippine species including *N. luzonicus* and *N. panayensis*. In soldier characters it is quite distinct from *N. matangensis* and *N. matangensiformis* with types of which we have compared it. From the former it differs in its narrower head, relatively longer rostrum, etc.; and from the latter, which it approaches more closely, it differs in being larger and in the lower antennal hump, etc. From *N. luzonicus* the alate of *N. meridianus* can hardly be distinguished, but the brown color of the alate seems characteristic as also the orange tinge of the soldier's head, the greater width of head, the much lighter color of the tergites, and other features. More complete knowledge may ultimately show these species and others of the *matangensis* group to be true (geographic) subspecies of a single or a very few species.

Distribution and biology.—Of the six vials of this species in the collection one was from Jolo. The others were from Palawan, two from Sir J. Brooke Point and three from Thumb Peak near Iwahig. All were collected by Taylor, who notes that the Jolo collection (313) was from a paper nest in wood. One collection from Sir J. Brooke Point was from runways on a dead log; one of the Thumb Peak collections taken at 2,000 feet was from a paper nest and the other two were from rotten wood.

14. NASUTITERMES OSHIMAI sp. nov. Text fig. 15.

Alate.—Unknown.

Soldier.—Head pale orange-brown, lighter behind; rostrum centrally darker, tergites barely pigmented.

Head and rostrum shaped as in fig. 15, *a* and *b*, very similar to, but smaller than, *N. panayensis;* rostrum slightly thicker at base than in the latter species. Mandible as in fig. 15, *b*.

Antennæ pale yellow, of twelve segments, slightly less than length of head with rostrum.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes oshimai sp. nov., from the type collection, No. 1509, Laguna.

Length of head and rostrum	1.47
Length of head without rostrum	0.90
Length of rostrum	0.57
Head production	0.24
Height of head	0.60
Width of head	0.90
Length of fore tibia	0.78
Head index	1.00
Head-rostrum index	0.63
Head production index	0.27
Leg elongation index	0.87

Systematic position and distribution.—This species is represented by two collections, from Paete, Laguna Province, Luzon, each containing a single soldier, which were collected by McGregor. These were sent to McGregor and the senior author by Doctor Oshima as autotypes of *N. gracilis*. They clearly disagree with Oshima's description and belong with the brown-headed *matangensis* group of species, being nearest to *N. panayensis* Oshima from which they differ distinctly in their much smaller size, much shorter hind tibia, and the lack of pigmentation of the abdominal tergites.

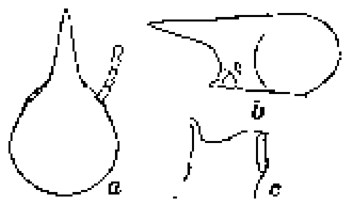

FIG. 15. *Nasutitermes oshimai* sp. nov., soldier: *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

This is the only nasute of this group known from Luzon, and there remains the possibility that it is actually from a southern island and was misplaced in handling. The two collections on hand are probably from the same colony. We take pleasure in naming the species for Dr. Masamitsu Oshima, pioneer student of Philippine termites.

16. NASUTITERMES CHAPMANI sp. nov. Text fig. 16.

Dealate (*fig. 16, a*).—Head brown, postclypeus and labrum yellowish brown; antennæ light brownish yellow; pronotum yellowish brown; mesonotum centrally brownish ivory white; tergites chestnut-brown; sternites pale yellow, laterally brownish. Head shaped as in fig. 16, *a*; width through eyes 1.65 mm.

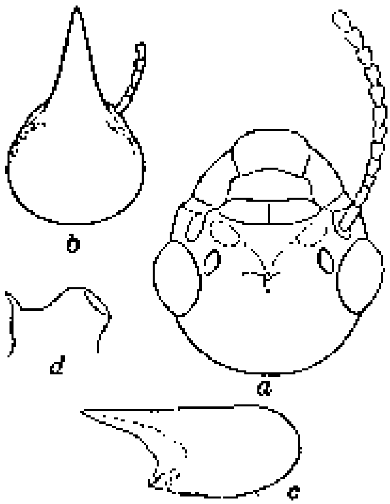

FIG. 16. *Nasutitermes chapmani* sp. nov.: *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

Fontanel (fig. 16, *a*) prominent, narrowly triangular, flaring anteriorly; about three-fourths as long as short diameter of ocellus.

Ocellus elliptical, long diameter about one-third the long diameter of eye; separated from eye by about one-third the diameter of ocellus.

Eye separated from lower margin of head by about one-sixth its own diameter, from upper margin of head by about one-fourth its own diameter, and from posterior margin by about seven-tenths its own diameter.

Measurements in millimeters of a dealate of Nasutitermes chapmani sp. nov., from collection 570, from Negros.

Length of body with head	7.27
Length of head	1.78
Length of head capsule	1.31
Width of head capsule	1.28
Width of head with eyes	1.65
Length of pronotum	0.79
Width of pronotum	1.49
Long diameter of eye	0.634
Short diameter of eye	0.518
Long diameter of ocellus	0.182
Short diameter of ocellus	0.140
Distance of ocellus from eye	0.040

Soldier (*fig. 16, b to d*).—Head orange-brown; rostrum darker at base and tip; tergites hardly pigmented.

Head and rostrum shaped as in fig. 16, *b* and *c*. Head low, only slightly elevated behind; dorsal profile nearly flat, only

faintly sinuous; rostrum very thick near base, tapering gradually to a sharp tip.

Antennæ of twelve segments, about two-thirds as long as head with rostrum; segment III longer than II and IV, which are subequal.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes chapmani sp. nov., from collection 945, from Negros.

Length of head with rostrum	1.53
Length of head without rostrum	0.96
Length of rostrum	0.57
Head production	0.30
Height of head	0.64
Width of head	0.99
Length of fore tibia	0.78
Head index	1.03
Head-rostrum index	0.59
Head production index	0.31
Leg elongation index	0.81

Systematic position.—*Nasutitermes chapmani* sp. nov. is most closely related to *N. panayensis* (Oshima) and *N. meridianus* sp. nov. The alate is larger than that of either species and has relatively larger eyes than has either of these species. In color it is much like *N. meridianus*, but the large eye distinguishes it, as also the smaller ocellus, much more sparsely haired head, and larger, differently shaped pronotum, as well as the orange color of antennæ, thorax, etc., in *N. meridianus*.

The soldier differs from *N. panayensis* in its smaller body with hardly chitinized sclerites, the lighter color of the head, and the narrower head with thick-based rostrum. From *N. meridianus* the soldier differs in the same way as from *N. panayensis* and in addition in the absence of the characteristic orange color of head, antennæ, sclerites, etc.

Distribution and biology.—Two of the three collections were taken on the Cuernos de Negros, above Dumaguete, one by Dr. A. W. Herre, at that time of the Philippine Bureau of Science; the other taken by the senior author and Dr. James Chapman, of Silliman Institute, for whom the species is named, was from a young colony in the dead wood of a limb stub 7 feet above the ground. The third was taken by Dr. E. H. Taylor from wood on the water reservation back of Zamboanga.

16. NASUTITERMES PARVUS sp. nov. Text fig. 17.

Alate.—Unknown.

Soldier (*fig. 17, a to c*).—Head gray smoky yellow-brown; rostrum light brown; tergites very faintly pigmented. Very small, less than 3 mm long.

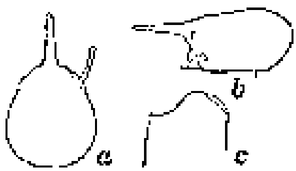

FIG. 17. *Nasutitermes parvus* sp. nov., soldier: *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

Head and rostrum shaped as in fig. 17, *a* and *b*, rostral hump prominent; head anteriorly depressed; rostrum narrowed near base with conspicuous sharp-tipped hump on front of head on either side of base of rostrum. Head covered with a coat of slender, curved, whitish hairs and a very few, stiff, spinelike hairs. Mandible with a vestigial free portion.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes parvus sp. nov., from the type collection, No. 814, from Jolo.

Length of head and rostrum	1.20
Length of head without rostrum	0.76
Length of rostrum	0.44
Head production	0.27
Height of head	0.48
Width of head	0.69
Length of fore tibia	0.54
Head index	0.91
Head-rostrum index	0.57
Head production index	0.35
Leg elongation index	0.71

Remarks.—This very characteristic little species is represented by a single collection, taken by Taylor on Jolo Island. Its small size, its peculiar head shape, the conspicuous projections on the head on either side of the rostrum, the strongly narrowed base of the rostrum, and the vestigial nature of the free portion of the mandible, as also the 11-segmented antennæ, seem to distinguish it readily from any other Philippine species, as well as from any other species of the genus known to us.

17. NASUTITERMES ROTUNDUS sp. nov. Text fig. 18.

Alate.—Unknown.

Soldier (*fig. 18, a to c*).—Head dull yellow; rostrum pale reddish; tergites pale yellow, very lightly chitinized.

Head and rostrum shaped as in fig. 18, *a* and *b*, dorsal profile concave despite a slight rostral hump; head depressed in front;

rostrum distally slightly uplifted. Head with a coat of slender whitish hairs and a few, scattered, spinelike hairs. Left mandible as in fig. 18, *c*.

Antennæ of twelve segments, about five-sevenths as long as head with rostrum, segments II and III subequal.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes rotundus sp. nov., from the type collection, No. 1154, from Cotabato, Mindanao.

Length of head and rostrum	1.62
Length of head without rostrum	0.96
Length of rostrum	0.66
Head production	0.24
Height of head	0.66
Width of head	1.02
Length of fore tibia	0.72
Head index	1.06
Head-rostrum index	0.69
Head production index	0.25
Leg elongation index	0.75

Remarks.—The single collection of this very distinct species was taken by Taylor on the Cotabato coast, Mindanao. Nothing is known of its biology.

16. NASUTITERMES BALINTAUACENSIS (Oshima). Text fig. 19.

Eutermes (Eutermes) balintauacensis OSHIMA, 1917, 1920.

Alate.—Unknown.

Soldier (fig. 19, a to c).—Head smoky yellow; rostrum darker, light yellow-brown; tergites pale yellow, very lightly chitinized.

Head and rostrum shaped as in fig. 19, *a* and *b*, rostrum long and slender, rostral hump long, conspicuous; constriction some distance behind antennæ. Mandible (fig. 19, *c*) with long apical portion. Head covered with very minute whitish hairs and scattered spinelike hairs of two sizes.

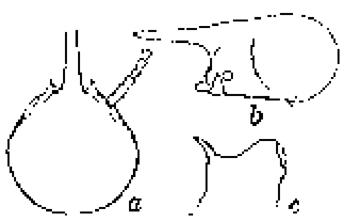

FIG. 18. *Nasutitermes rotundus* sp. nov., soldier: *a*, head in dorsal view; *b*, head lateral view, *c*, left mandible.

Antennæ of twelve segments, nearly three-fourths as long as head with rostrum; segments II and III shortest, subequal.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes balintauacensis (Oshima), from collection 117, from Taytay, Rizal Province, Luzon.

Length of head and rostrum	1.32
Length of head without rostrum	0.78
Length of rostrum	0.54
Head production	0.27
Height of head	0.53
Width of head	0.78
Length of fore tibia	0.66
Head index	1.00
Head-rostrum index	0.69
Head production index	0.35
Leg elongation index	0.85

Variation.—Despite some variation in head width and color, the soldiers of the eight collections at hand are very similar. The head index ranges from 0.93 to 1.00 and the head-rostrum index from 0.60 to 0.70.

Systematic position.—This species can be readily distinguished from other known Philippine species with awl-shaped rostra by the very weak constriction of the head (fig. 19, *a*) and the long free portion of the mandible (fig. 19, *c*). It approaches the species of the *constrictoides* group, but differs in the very slight nature of the constriction.

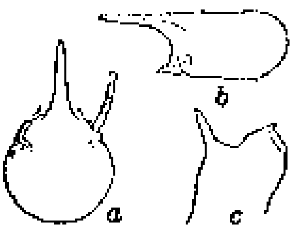

FIG. 19. *Nasutitermes balintauacensis* (Oshima), soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

Distribution and biology.—The eight collections are all from central Luzon: Rizal, Laguna, and Bataan Provinces. Three are from Mount Mariveles at an altitude of 1,000 to 5,000 feet, one from Mount Maquiling (2,000 feet), one from Limay, Bataan, and one from Paete, Laguna (autotype). Oshima described the species from material from Balintawac, Rizal.

It has been encountered most commonly on mountain slopes, which indicates its association with the original forest. Nothing is known of its biology save that one colony was found by the senior author, attacking the roots of a *Hevea* rubber tree in the grounds of the School of Forestry, near Los Baños, Laguna. The weakened tree was blown down, thus exposing the termites.

17. NASUTITERMES TAYLORI sp. nov. Text fig. 20.

Alate (fig. 20, a).—Dorsal surface dark smoky brown, ventral surface light brown; head dark brown, postclypeus and labrum

pale brown; antennæ brown; pronotum dark brown; mesonotum deep ivory brown; tergites very dark smoky brown; sternites light brown, centrally pale; wing membrane dusky brown; a transparent strip extending from wing scale to posterior third of wing, radius sector deep brown throughout; costal margin brown, subcostal stripe slightly narrower and lighter than radius sector.

Head small, width through eyes 1.32 mm; shaped as in fig. 20, *a*.

Fontanel gleaming white, conspicuous, narrowly lenticular, at least as long as ocellus. Ocellus elliptical, long diameter not quite twice short diameter; long diameter about half diameter of eye; separated from eye by about long diameter of ocellus.

Eye small, projecting; separated from lower margin of head by about one-third its own diameter, from upper margin of head by more than one-half its diameter, and from posterior margin by more than its own diameter.

Measurements in millimeters of a typical alate of Nasutitermes taylori sp. nov., from the type collection, No. 1158, from Cotabato, Mindanao.

Length over all	13.06
Length of forewing	11.04
Width of forewing	2.94
Length of head	1.51
Length of head capsule	1.05
Width of head capsule	1.08
Width of head with eyes	1.33
Length of pronotum	0.69
Width of pronotum	1.12
Diameter of eye	0.36
Long diameter of ocellus	0.14
Short diameter of ocellus	0.12
Distance of ocellus from eye	0.09

Soldier (*fig. 20, b to f*).—Head light smoky yellow-brown, lighter behind; rostrum red, dark at base; tergites brown, heavily chitinized.

Head and rostrum shaped as in fig. 20, *b to e*; rostrum long, rostral hump conspicuous; constriction distinct; a sparse growth of slender whitish hairs on head.

Antennæ of twelve or thirteen segments, when thirteen segments, II and IV shortest, III twice as long as IV.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes taylori sp. nov., from collection 1158, from Cotabato, Mindanao.

Length of head with rostrum	1.62
Length of head without rostrum	0.96

Length of rostrum	0.66
Head production	0.33
Height of head	0.62
Width of head	0.91
Length of fore tibia	0.84
Head index	0.95
Head-rostrum index	0.69
Head production index	0.34
Leg elongation index	0.88

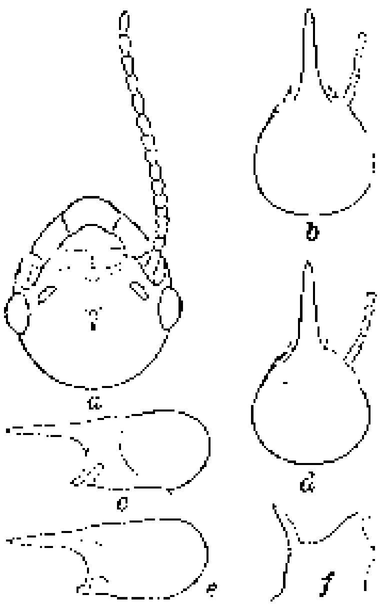

FIG. 20. *Nasutitermes taylori* sp. nov.; *a*, head of alate in dorsal view; *b* and *d*, heads of soldiers in dorsal view; *c* and *e*, heads of soldiers in lateral view; *f*, left mandible of soldier.

Remarks.—The two collections of this species were taken by Taylor, one on Tatayan Island, off the Cotabato coast of Mindanao, and the other near Caldera, Cotabato. One taken in early April contained numerous fully pigmented alates.

Superficially, the soldiers of this species are close to those of *N. castaneus* (Oshima), but differ in having larger heads and relatively shorter rostra, the rostral index being less than 0.70, while that of *N. castaneus* is more than 0.75. The pronotum also is less heavily chitinized in *N. taylori*. Differences will be seen in the mandibles (figs. 20, *f*, and 21, *c*), but these may lose significance when the varietal range is better known.

25. NASUTITERMES CASTANEUS (Oshima). Text fig. 21.

Eutermes (Eutermes) castaneus OSHIMA, 1920.

Alate.—Unknown.

Soldier (fig. 21, a to c).—Head smoky brownish yellow; rostrum slightly darker at base, reddish distally; tergites brownish yellow, well pigmented.

Head and rostrum shaped as in fig. 21, *a* and *b*. A few slender whitish hairs on head; rostral hump prominent and long, a sharply depressed saddle at its base; rostrum long and slender.

Antennæ of twelve or thirteen segments; when thirteen segments, II and IV shortest, III twice as long as IV.

Measurements in millimeters, and indices, of two paratype soldiers of Nasutitermes castaneus (Oshima), from collection 1501, from Culasi, Panay.

Length of head and rostrum	1.56	1.50
Length of head without rostrum	0.88	0.86
Length of rostrum	0.68	0.66
Head production	0.27	0.27
Height of head	0.63	0.60
Width of head	0.93	0.83
Length of fore tibia	0.81	0.78
Head index	1.05	0.97
Head-rostrum index	0.77	0.77
Head production index	0.31	0.31
Leg elongation index	0.92	0.94

Remarks.—The autotype collection available through the kindness of Doctor Oshima is from Culasi, Panay, and was collected by McGregor. The species may be distinguished from *N. taylori* sp. nov., described above, which it approaches in many ways, chiefly by the relatively longer rostrum and shorter head of the soldier in *N. castaneus.*

21. NASUTITERMES MCGREGORI (Oshima).

Eutermes (Ceylonitermes) mcgregori OSHIMA, 1916, p. 36 (soldier, not imago), pl. 1, fig. 10, nec *Eutermes (Ceylonitermes) mcgregori* Oshima, 1920 (see under *N. panayensis* Oshima).

Alate.—Unknown. See discussion below.

Soldier.—(Derived from Oshima's description and figure.) Head pale brown, rostrum darker; tergites pale yellowish white, lightly chitinized.

Head elongated, pear-shaped, with conspicuous constriction; dorsal profile nearly concave; rostrum slender, "conical," relatively long; head-rostrum index under 0.73 (based on Oshima's measurements).

Antennæ of twelve segments; II to IV subequal.

Measurements in millimeters of a soldier of Nasutitermes mcgregori (Oshima).

Length of body	4.00
Length of head with rostrum	1.56
Length of head	0.90
Width of head	0.93
Width of pronotum	0.46

Worker.—"Basal portion of clypeus *shorter* than half the width."

Remarks.—This species was described by Oshima in 1916 on the basis of material collected by McGregor in Laguna Province,

Luzon. He ascribes to it a dealate, which he does not figure but of which he says, "pronotum considerably broader than head" and "anterior wing stumps covering anterior half of the posterior," characters which indicate that he was dealing with a species of the Rhinotermitidæ, probably *Schedorhinotermes* sp.

The soldier that he illustrates belongs to the *constrictoides* group but differs strikingly in the long rostrum.

In 1920 he reported a collection taken by McGregor in Antique Province, Panay, as belonging to this species. Examination of individuals from this colony sent to the Bureau of Science and to the senior author as autotypes of *N. mcgregori* shows them to belong to his *N. panayensis*.

Oshima placed this species in the subgenus *Ceylonitermes*. It must be admitted that there is a similarity in shape of head between the soldier of *N. mcgregori* and that of *Eutermes* (*Ceylonitermes*) *escherichi* Holmgren (1911). The soldier of *N. mcgregori* lacks the elongated antennæ and legs, which characterize the soldier in *Ceylonitermes*; and, of more importance, Oshima in his description of the worker states, "basal portion of the clypeus shorter than half the width," while Holmgren places *Ceylonitermes* in the group of subgenera the workers of which have a postclypeus about as long as half its width ("Clypeobasole der Arbeiter stets etwa so lang wie seine halbe Breite"). In the description of *E.* (*C.*) *escherichi* he says: "Clypeus gross, aufgetrieben, so lang wie seine halbe Breite." We have, therefore, placed the species in the subgenus *Nasutitermes* sen. str. (= *Eutermes* sen. str. Holmgren).

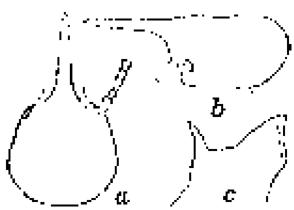

FIG. 21. *Nasutitermes* [illegible] (Oshima), soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

22. NASUTITERMES CONSTRICTICEPS sp. nov. Text fig. 22.

Alate.—Unknown.

Soldier (*fig. 22, a to c*).—Head smoky brown; rostrum dark, distally pale reddish; tergites brown, well chitinized.

Head and rostrum shaped as in fig. 22, *a* and *b*. Head expanded and greatly produced behind; head constricted some distance behind the antennæ; rostrum relatively short, dorsal profile in lateral view concave, rostral hump wanting or only faintly suggested.

Mandibles (fig. 22, *c*) with straight or concave sides and a long, sharp, free portion in line with the side.

Antennæ of thirteen segments, somewhat elongated, slightly longer than length of head with rostrum; segments II and IV shortest, subequal; segment III elongated, at least as long as elongated distal segments.

Measurements in millimeters, and indices, of three soldiers of Nasutitermes constricticeps sp. nov., from the type collection, No. 1159, from Zamboanga, Mindanao.

	Largest.	Smallest.	Average.
Length of head and rostrum	1.68	1.56	1.59
Length of head without rostrum	1.20	1.05	1.11
Length of rostrum	0.48	0.53	0.48
Head production	0.54	0.42	0.48
Height of head	0.72	0.60	0.62
Width of head	1.02	0.87	0.90
Length of fore tibia	0.84	0.75	0.81
Head index	0.85	0.83	0.81
Head-rostrum index	0.40	0.49	0.43
Head production index	0.45	0.40	0.43
Leg elongation index	0.79	0.72	0.76

Remarks.—This very distinct species is based on a single collection taken by Taylor in the Caldera Bay Mountains, Zamboanga Province, Mindanao. Nothing is known of its biology.

The dark, very markedly constricted head (fig. 22, *a*), swollen behind, and the dark, strongly chitinized tergites serve to distinguish this species from *N. busuangæ* sp. nov. and *N. brevicornis* sp. nov.

13. NASUTITERMES BUSUANGÆ sp. nov. Text fig. 23.

Alate.—Unknown.

Soldier (fig. 23, a to c).—Head orange-yellow; rostrum reddish orange; tergites dull yellow, weakly chitinized.

Head and rostrum shaped as in fig. 23, *a* and *b;* dorsal profile deeply concave; rostrum somewhat uplifted; constriction not so deep as in *N. constricticeps;* anteroventral corners flaring (fig. 23, *a*). Mandible (fig. 23, *c*) broad, with oblique sides; free apical portion spinelike, much shorter than in *N. brevicornis* sp. nov. and much longer than in *Subulitermes mariveles* sp. nov.

Antennæ of thirteen segments, somewhat elongated, about six-fifths as long as head with rostrum; segment II shortest, III longest, IV and V subequal.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes busuangæ sp. nov., from the type collection. No. 1215, from Busuanga Island.

Length of head and rostrum	1.52
Length of head without rostrum	1.04
Length of rostrum	0.48
Head production	0.32
Height of head	0.57
Width of head	0.87
Length of fore tibia	0.86
Head index	0.84
Head-rostrum index	0.46
Head production index	0.31
Leg elongation index	0.83

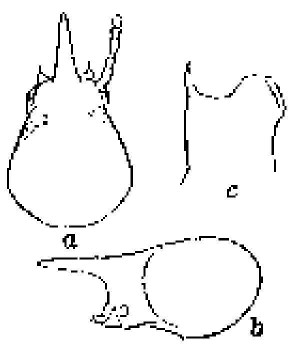

FIG. 22. *Nasutitermes constricticeps* sp. nov., soldier; a, head in dorsal view; b, head in lateral view; c, left mandible.

Remarks.—The single collection on which this species is based was taken by Taylor under coconut débris at Coron on Busuanga Island, of the Calamianes group, between Mindoro and the northern end of Palawan. Nothing is known of its biology.

This species is distinguished from nearly related species by the widely flaring anteroventral corners of the head capsule (fig. 23, *a*), the oblique sides of its mandible (fig. 23, *c*), and other characters.

24. NASUTITERMES BREVICORNIS sp. nov. Text fig. 24.

Alate.—Unknown.

Soldier (fig. 24, a to e).—Head and rostrum orange-brown; tergites light smoky brown, well chitinized.

Head and rostrum shaped as in fig. 24, *a* to *d;* head pear-shaped, strongly narrowed in front, anteroventral corners flaring; head elevated and greatly produced behind, depressed in front; rostrum short, uplifted; dorsal profile generally concave, but sinuous due to the low rostral hump. Mandible (fig. 24, *e*) with straight lateral side and usually long free portion.

Antennæ of thirteen segments, somewhat elongated, five-fourths as long as head with rostrum; segment III longest, II and IV smallest, subequal.

Measurements in millimeters, and indices, of a typical soldier of Nasutitermes brevicornis sp. nov., from the type collection, No. 1167, from Cotabato, Mindanao.

Length of head and rostrum	1.44
Length of head without rostrum	0.98
Length of rostrum	0.46
Head production	0.39
Height of head	0.68
Width of head	0.90
Length of fore tibia	0.84
Head index	0.92
Head-rostrum index	0.46
Head production index	0.40
Leg elongation index	0.85

Remarks.—Two collections of this species were taken by Taylor in Cotabato Province, Mindanao. Nothing is known of its biology.

The relatively very short rostrum, giving a head index of less than 0.50, and the very long apical portion of the mandible (fig. 24, *e*) distinguish this species. Variation in width of head is brought out in fig. 24, *a* and *b*, and in shape of head in lateral view in fig. 24, *c* and *d*.

Genus SUBULITERMES Holmgren

25. SUBULITERMES MARIVELES sp. nov. Text fig. 25.

Alate (*fig. 25, a*).—Head very dark black-brown, postclypeus light brown, labrum very pale; antennæ brown; pronotum rusty brown; mesonotum centrally ivory brown; tergites dark brown; sternites pale yellow-brown, laterally smoky brown; wing membrane pale brown, veins brown, radius sector continuous with dark brown stripe of same width, subcostal stripe brownish yellow, about as wide as radius sector, separated from brown stripe by an irregular clear line; a narrow area between radius sector and costa.

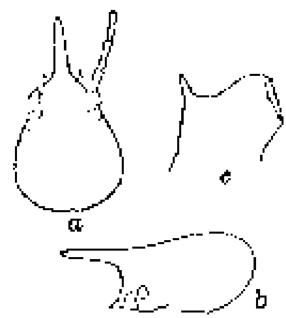

FIG. 23. *Nasutitermes basungae* sp. nov., soldier: *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

Head small; width through eyes 1.32 mm; head shaped as in fig. 25, *a*.

Fontanel (fig. 25, *a*) broad, abruptly flaring anteriorly, terminating in two sharp lateral points; nearly twice as long as ocellus.

Ocellus circular, diameter about one-third diameter of eye; separated from eye by about one and one-half times diameter of ocellus.

Eye small, separated from lower margin of head by about one-fourth its diameter, from upper margin of head by more than one-half its diameter, and from posterior margin by more than its own diameter.

Antennæ of fourteen or fifteen segments; III smallest, very short and narrow; II and IV subequal; distal segments somewhat elongated.

Pronotum longer than half its breadth, anterolateral corners broadly rounded; sides converging posteriorly, rounding slightly into nearly straight, medially slightly concave, posterior border.

Measurements in millimeters of a typical alate of Subulitermes mariveles sp. nov., from the type collection, No. 684, from Mount Mariveles, Bataan Province, Luzon.

Length over all	14.72
Length of forewing	13.20
Width of forewing	2.86
Length of head	1.54
Length of head capsule	1.00
Width of head capsule	0.97
Width of head with eyes	1.25
Length of pronotum	0.71
Width of pronotum	1.07
Diameter of eye	0.34
Long diameter of ocellus	0.15
Short diameter of ocellus	0.11
Distance of ocellus from eye	0.11

Soldier (*fig.* 25, *b to d*).—Head light smoky brown; rostrum dark smoky brown, with faintly reddish tip; tergites very pale yellow-brown, very slightly chitinized.

Head and rostrum shaped as in fig. 25, *b* and *c*, dorsal profile sinuous, rostral hump distinct, low and long, set off by grooves from somewhat swollen posterior portion of head and anteriorly from somewhat straight ventral margin of the head. Head with sparse growth of short whitish hairs.

Mandible (fig. 25, *d*) long and narrow, with very small free portion and anteriorly projecting molar region.

Antennæ of twelve segments, not elongated, slightly shorter than length of head with rostrum; segments II and III shortest, subequal.

Measurements in millimeters, and indices, of a typical soldier of Subulitermes mariveles sp. nov., from the type collection, No. 484, from Mount Mariveles, Bataan Province, Luzon.

Length of head and rostrum	1.45
Length of head without rostrum	0.94
Length of rostrum	0.51
Head production	0.30
Height of head	0.57
Width of head	0.81
Length of tibia	0.75
Head index	0.86
Head-rostrum index	0.54
Head production index	0.32
Leg elongation index	0.80

Remarks.—The three collections are all from the slopes of Mount Mariveles at 1,000 and 1,500 feet altitude, collected by McGregor and Light, June 21, 1921, at which time mature alates were found in one colony. Nothing is known of the biology.

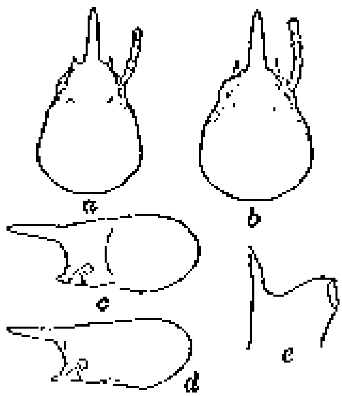

FIG. 24. *Nasutitermes brevicornis* sp. nov., soldier: *a* and *b*, heads in dorsal view; *c* and *d*, heads in lateral view; *e*, left mandible.

The soldier of this species is easily distinguished from the other Philippine species with long pear-shaped heads, short rostra, and a more or less distinct constriction behind the antennæ by the inconspicuous nature of the constriction, the lack of elongation of the antennæ, the short antennal segment III, and the vestigial nature of the apical portion of the mandible.

The vestigial nature of the mandibles, together with the fact that the postclypeus of the worker is about one-half as long as wide, seems to necessitate placing this species in the genus *Subulitermes* pending a more careful investigation of the groups of nasute termites.

26. SUBULITERMES MINDANENSIS sp. nov. Text fig. 25.

Alate (*fig. 26, a*).—Generally dark brown; head very dark brown, postclypeus and labrum pale yellow-brown; antennæ brown; pronotum rusty brown; mesonotum ivory brown; tergites dark brown; sternites brown, centrally pale; wing membrane dusky brown, radius sector deep brown, costal margin

brown, subcostal stripe barely visible; cubitus and median separated by a narrow clear area extending from wing scale to central point of wing.

Head small; width through eyes 1.02 mm; head shaped as in fig. 26, *a*.

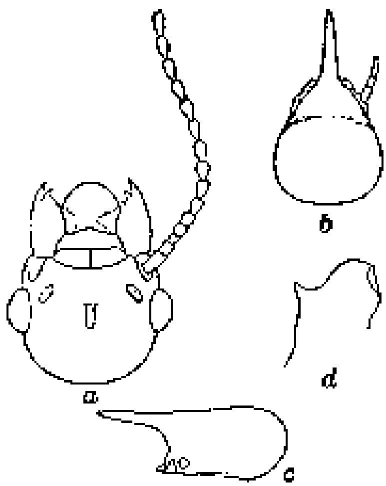

FIG. 26. *Subulitermes mindanaensis* sp. nov.: *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

Fontanel narrow, club-shaped, widest posteriorly; about two-thirds as long as ocellus.

Ocellus nearly circular, slightly less than one-third diameter of eye; separated from eye by diameter of ocellus or somewhat more.

Eye small, separated from the lower margin of head by about one-fourth its own diameter, from upper margin of head by about one-third its own diameter, and from posterior margin by about its own diameter.

Antennæ of thirteen segments, III typically shortest.

Pronotum long, sides converging strongly posteriorly to curve into strongly bilobed posterior margin.

Measurements in millimeters of a typical alate of Subulitermes mindanaensis sp. nov., from the type collection, No. 1144, from Cotabato, Mindanao.

Length over all	11.03
Length of forewing	9.02
Width of forewing	2.02
Length of head	1.13
Length of head capsule	0.82
Width of head capsule	0.87
Width of head with eyes	1.04
Length of pronotum	0.49
Width of pronotum	0.84
Diameter of eye	0.285
Long diameter of ocellus	0.10
Short diameter of ocellus	0.08
Distance of ocellus from eye	0.08

Soldier (*fig. 26, b to d*).—Head light smoky yellow; rostrum dark (reddish) over entire length; tergites pale yellow, very slightly chitinized.

Head and rostrum shaped as in fig. 26, *b* and *c*, head broad posteriorly, converging anteriorly, without lateral constriction; profile of head convex due to anterior depression and weak rostral hump; rostrum short, awl-shaped; an inconspicuous hump on either side of head near base of rostrum; mandible (fig. 26, *d*) extremely reduced, apical portion obsolete and that side of mandible reduced.

Antennæ of eleven segments, about two-thirds as long as head with rostrum.

Measurements in millimeters, and indices, of a soldier of Subulitermes mindanensis sp. nov., from collection 1144, Cotabato Province, Mindanao.

Length of head and rostrum	1.41
Length of head without rostrum	0.87
Length of rostrum	0.54
Head production	0.24
Height of head	0.59
Width of head	0.87
Length of fore tibia	0.72
Head depression	0.12
Head index	1.00
Head-rostrum index	0.62
Head production index	0.28
Leg elongation index	0.83
Head height index	0.68
Head depression index	0.20

Remarks.—There are three collections of this species, all made by Taylor at different localities in Cotabato Province, Mindanao, in April, 1923. Two of these contain numerous alates. Nothing is known of their biology.

The species is readily distinguished from all other species known to us by the vestigial mandible of the soldier, which not only lacks a free portion, but which has the anterolateral region of the mandible reduced. This, with the long swollen postclypeus of the worker, places the species in *Subulitermes*. Without dissection the soldier somewhat resembles that of *N. balintauacensis* (Oshima), from which it may be distinguished by the depressed head with convex lateral profile as well as by the shorter rostrum.

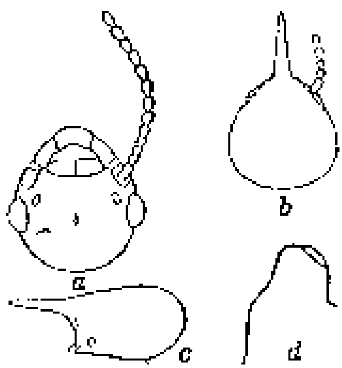

FIG. 26. *Subulitermes mindanensis* sp. nov.: *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

FIG. 11. *Nasutitermes simulans* sp. nov.; *a* and *b*, heads of two soldiers from the same colony, in dorsal view, to show range of variation; *c* and *d*, heads of two soldiers from the same colony, in lateral view, to show range of variation; *e* and *f*, left mandibles of soldiers.

12. *Nasutitermes latus* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c* and *d*, left mandibles.

13. *Nasutitermes panayensis* (Oshima); *a*, head of alate in dorsal view; *b* to *d*, heads of soldiers in dorsal view (*b* from an autotype from Culasi, Panay; *c* from a specimen from Tibiao, Panay, labeled by Oshima "*Ceylonitermes Megregori*" from which, of course, it differs very widely; *d* from an abnormal soldier with thick rostrum, taken in Negros); *e*, head of typical soldier in lateral view; *f*, head of abnormal soldier (same as *d*) in lateral view; *g* to *j*, left mandibles of soldiers (*j* from abnormal soldier *d* and *f*).

14. *Nasutitermes meridianus* sp. nov.; *a*, head of alate in dorsal view; *b* to *d*, heads of soldiers in dorsal view, to show range in size and proportions, all from Palawan; *e*, head of soldier in lateral view; *f* to *i*, left mandibles of soldiers to show variation.

15. *Nasutitermes oshimai* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

16. *Nasutitermes chapmani* sp. nov.; *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

17. *Nasutitermes parvus* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

18. *Nasutitermes rotundus* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

19. *Nasutitermes balintauacensis* (Oshima), soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

20. *Nasutitermes taylori* sp. nov.; *a*, head of alate in dorsal view; *b* and *d*, heads of soldiers in dorsal view; *c* and *e*, heads of soldiers in lateral view; *f*, left mandible of soldier.

21. *Nasutitermes castaneus* (Oshima), soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

22. *Nasutitermes constricticeps* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

23. *Nasutitermes busuangae* sp. nov., soldier; *a*, head in dorsal view; *b*, head in lateral view; *c*, left mandible.

24. *Nasutitermes brevicornis* sp. nov., soldiers; *a* and *b*, heads in dorsal view; *c* and *d*, heads in lateral view; *e*, left mandible.

25. *Subulitermes mariveles* sp. nov.; *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

26. *Subulitermes mindanensis* sp. nov.; *a*, head of alate in dorsal view; *b*, head of soldier in dorsal view; *c*, head of soldier in lateral view; *d*, left mandible of soldier.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

MAY 1, 1936

American society for testing materials. Index to A. S. T. M. standards and tentative standards. Philadelphia, Pa., The Society, 1936. 159 pp.

HUBBARD, G. E. Eastern industrialization and its effect on the west with special reference to Great Britain and Japan. London, Oxford univ. press, 1935. xxii + 395 pp., tables. Price, $7.

MACEACHERN, MALCOLM T. Hospital organization and management. Chicago, Physicians record co., 1935. xxiv + 944 pp., front., plates, tables, diagrs., forms. Price, $7.50.

NAVARRO BORRAS, F. Curso general de matemáticas aplicadas a la física, a la química y a las ciencias naturales explicado en la facultad de ciencias de Madrid. Madrid, C. Bermejo, 1936.

SINHA, BASANTI CHARAN. Acidosis and the dietetic treatment of diseases. Calcutta, The Swasthya Sangha, 1935.

STOKLEY, JAMES. Star and telescopes. N. Y. and London, Harper, 1936. xiii + 319 pp., front., illus., plates. Price, $3.

JUNE 1, 1936

American society for testing materials. Report of committee B-6 on die-cast metals and alloys. Philadelphia, Pa., 1935. 46 pp., tables, diagrs. Price, $0.75.

BOSTON, ORLAN W. A bibliography on the cutting of metals. Pt. II. Ann Arbor, Michigan, Edward brothers, 1935. 202 pp., tables. Price, $2.50.

CAMPBELL, ARGYLL, and E. P. POULTON. Oxygen and carbon dioxide therapy. London, Oxford university press, 1934. xv + 179 pp., illus., plates, tables, diagrs.

HALL, Sir DANIEL, [and others]. The frustration of science. London, Allen & Unwin, 1935. 144 pp. Price, $1.

HAMMOND, T. E. Infections of the urinary tract. London, H. K. Lewis & co., 1935. x + 250 pp. Price, $2.75.

KLINEBERG, OTTO. Race differences. N. Y. and London, Harper, 1935. ix + 367 pp., tables. Price, $2.50.

MORENO, J. L. Who shall survive? A new approach to the problem of human interrelations. Washington, D. C., Nervous and mental disease publishing co., 1935. xvi + 437 pp., illus., diagrs. Price, $4.

PAULIAN, D. Tumeurs de l'encéphale; contributions a l'etude anatomo-clinique des tumeurs intracraniennes et du repérage ventriculaire. Paris, Masson et cie, 1935. iii + 213 pp., illus. Price, $1.25.

SCHULTZ, THEODORE W. Vanishing farm markets and our world trade. Boston, N. Y., 1935. 41 pp., diagrs. Price, $0.50.

STEPHENSON, THOMAS. Incompatibility in prescriptions and how to avoid it with a dictionary of incompatibilities. 4th ed., rev. and enl. Edinburgh, The Prescriber offices, 1935. vii + 62 pp. Price, $2.

REVIEWS

Men, Money and Molecules. By Williams Haynes. Doubleday, Doran & Co., New York, 1936. 186 pp. Price, $1.50.

This book gives a very interesting and popular account of the development of the American chemical industry.

The average person scarcely realizes the magnitude of this industry, for the value of chemicals produced annually in the United States is greater than the combined annual production of Germany, England, France, Italy, Japan, and Russia.

The United States has abundant supplies of raw materials, and there are now in operation the most complicated modern types of chemical enterprises, such as the manufacture of dyes, fixed nitrogen, medicinal compounds, and numerous other products.

The World War awakened the public to the importance of chemicals. The spread of chemical processes through most industries has brought the manufacture of chemicals from an inconspicuous and wholly auxiliary position to a pivotal place as the supplier of materials that have become prime necessities of all manufacturing.

All sorts of raw materials are likely to be appraised upon the basis of their chemical constituents as the chemicalization of industries proceeds.

This is, indeed, a very interesting and instructive little book that should be widely read. It also contains an American chemical chronology beginning with the production of wood tar and potash in Virginia in 1608.—A. P. W.

Lobar Pneumonia and Serum Therapy. By F. T. Lord and Roderick Heffron. The Commonwealth Fund, New York, 1936. 91 pp. Price, $1.

This is a handbook of well-established bacteriological and immunological principles as applied to the diagnosis and treatment of lobar pneumonia in Massachusetts. The authors' experience in the successful application of antipneumococcus serum therapy in the state since 1931 prompts them to advocate its wider use in general medical practice. For this purpose the rapid typing and early administration of the type-specific antipneumococcus serum is essential. The dosage and the technic of administration

of the serum are given in detail. As in all serotherapy, proper selection of patients suitable for serum treatment through personal inquiry and sensitivity tests is emphasized as a precaution against troublesome and possibly fatal allergic reactions.

In the authors' experience timely and proper administration of the antiserum treatment results in marked improvement within eight to twenty-four hours after the initial injection, particularly in type I. Cyanosis and dyspnœa are relieved, the temperature drops, and the patient becomes clearer mentally. The course of the acute symptoms is shortened and made milder. Bacteriæmia is prevented or, if present, is readily checked. The mortality rate is reduced from 25 to 11.1 per cent in type I infections and from 41 to 27.2 per cent in type II. The high fatality rate in bacteriæmic cases is also considerably lowered.

Since, at present, effective serum therapy in pneumonia is confined to type I and II infections (the causative agents in about 60 per cent of lobar pneumonia cases in temperate climates) this method of treatment is of little value in the Philippines, where the offending organism in 80 per cent of pneumonia patients is of the heterogenous type IV.— W. V.

Hospital Organization and Management. By M. T. MacEachern. Physicians' Record Co., Chicago, 1935. 944 pp., illus. Price, $7.50.

Although Doctor MacEachern's qualifications by training and experience in hospital organization and management are not known, after a careful perusal of his book he reveals himself to us as one possessing a rich background. For the first time we have the advantage of having for our guidance a vast array of facts on all phases of hospital organization and management thoroughly and clearly presented in a single volume. Heretofore, we have had texts covering only some phases of hospital organization and management superficially discussed and of very limited scope.

Of special interest in this book is the broad discussion of the principles of organization with the corresponding charts which should appeal not only to hospital directors, superintendents, doctors, nurses, and other types of personnel, but even to the patients and the public, because of the vividness with which they picture the proper relationship that should exist between the persons that manage the hospital and those that they are supposed to serve. This together with the chapter on hospital ethics will remove many of the mistaken conceptions of responsibility and authority held by many hospital workers.

Two special features that will be found of great help by hospital personnel or would-be hospital organizers and administrators are the lists of the needed equipment, supplies, and materials for each hospital department, and the suggested diagram of certain services. There is no gainsaying the fact that we have experienced much waste of money and effort with the consequent ineffectiveness and inefficiency in organizing and administering hospitals without guidance coming from experience based upon keen analytic investigation, such as shown in Doctor MacEachern's book.

Doctor MacEachern lays emphasis on many modern phases of hospital organization and administration heretofore untouched. His work is exhaustive, from the early history to the twentieth century hospital, and covers such topics as the need for survey, women's auxiliary, the admitting department and it psychology, and the out-patient department. The medical social service, ethics, and public education are needed innovations in a progressive hospital, which receive as yet very negligible attention in the Philippines. These departments should be considered essential and integral parts of the hospital and should receive as much attention as other parts if the hospital is to keep pace with progressive medicine and advancing civilization.—A. P. V.

Pre-Medical Care. Comp. & ed. by E. C. Buehler. Noble and Noble, New York, 1935. 360 pp. Price, $2.

The book presents an exhaustive analysis of the pros and cons of state medicine. It is a series of articles which try to justify state medicine and, at the same time, present the disadvantages of the system. In places where health insurance has been established, the result of this system is very encouraging. On the other hand, the dark side of pre-medical care, as practiced, is the pauperization of the medical profession.

The point stressed in the book is the inability of the people to pay for adequate, proficient medical service. Hence, by group practice, the results of medical researches that have been found through years of individual effort among the members of the medical profession will find practical application to suffering humanity. Against it is the fact that, with socialized medicine, the free choice of physicians is entirely eliminated. On the whole, the book is a complete, practical presentation of socialized medicine, presenting both the advantages and the disadvantages of the system and calling attention to the point that the people are becoming less and less able to spend directly for efficient

medical service, including hospitalization, dentistry, and nursing care.

The book is worth while reading, because it is not a passionate plea for one system or another. It gives the reader an opportunity to weigh the facts presented with an open mind.—A. V.

The Physiology of Domestic Animals. By H. H. Dukes. Comstock Publishing Co., Ithaca, New York, 3d rev. ed., 1935. 643 pp., illus. Price, $6.

For years there has been a great need for an up-to-date English textbook on veterinary physiology, and the appearance of Professor Dukes's book is most gratifying.

The book deals with the physiology of all domestic animals, including fowls, giving valuable data and results of the latest scientific researches and investigations. It is backed by the author's experience and observations of more than a decade as a teacher and zealous researcher. The subject matter is divided into eleven parts of forty chapters. The introductory chapter, written by Prof. E. A. Hewitt, of Iowa State College, treats of the physicochemical basis of various phenomena involved in body functions. The succeeding chapters deal with the functional characteristics of the blood and lymph, the various systems of organs and tissues, and metabolism. The last part, which gives the physiology of reproduction, has been contributed by Prof. G. W. McNutt, of Washington State Veterinary College. The discussions of the physiology of the digestive tract, the endocrine glands, and the reproductive organs are especially interesting and practical.

The book is profusely illustrated. It also abounds in citations of authorities in the field of physiology. The comprehensive lists of references at the end of each part afford the interested student a lead into a more detailed survey of the literature on a given topic. The subject matter is so arranged that for purposes of class-room instruction assignment could start with any one of the eleven parts, without danger of materially impairing the value of the text.

While the book deals in large measure with the theoretical expositions of the fundamental laws of the functions of the different tissues and organs of the animal body, much attention is also devoted to the practical or applied aspects of the subject matter dealt with. Throughout the book the author and his collaborators have expressed their thoughts clearly and concisely, making it easy for the student to grasp the facts presented. The book will be found very useful not only by the

veterinary student and practitioner for whom it has been written primarily, but also by the student of animal husbandry, animal nutrition, and comparative physiology.—A. C. G.

The World Agricultural Situation in 1933–1934. International Institute of Agriculture, Rome. 502 pp. Price, $2.50.

A periodical publication of the International Institute of Agriculture, the 500-page book presents an extensive survey of the general trends of the present economic situation in world agriculture and of the agricultural policies and conditions in different countries. Statistical tables on production, exports, imports, and index numbers of prices of various products are widely distributed in the book with their corresponding annotations and explanations.

The first part of the economic commentary deals with the universal conditions and problems in agriculture—national planning and world economy, movements of prices, notes on market conditions, and coördination of the various forms of economic activities with the aim in view of achieving economic balance and prosperity. Mention is made of the interventions undertaken by the governments of different countries in behalf of agricultural adjustment, prominent among which are the Italian Corporations Law of 1934, the Five Year Plan of Soviet Russia, and the Agricultural Adjustment Act of the Roosevelt administration. The principal commercial products of the world are discussed comparatively with the preceding years in regard to acreage, production, yield per hectare, and movement of prices represented in the form of index numbers based on the average prices of 1927.

The second part of the volume is a detailed study of the conditions and policies in thirty important agricultural countries from Australia to the United States. Under each country are two separate chapters dealing with government measures of farm relief and with the economic conditions of agriculture. Emphasis is laid on the various steps made by the government of each country on behalf of the farmer and on the fluctuations in production and prices and their effects on the general agricultural situation.—L. Ma. G.

Tumeurs de l'Encephale. Contributions à l'Etude Anatomoclinique des Tumeurs Intra-craniennes et du Repérage Ventriculaire. Par D. Paulian. Masson et Cie., Paris, 1935. 213 pp. Price, $1.25.

Approximately the first third of this monograph is devoted to an up-to-date account of brain tumors, with particular reference

to their classification, description, and diagnosis, and with a detailed description of the different technics employed in ventriculography and the interpretation of the ventriculographic pictures. The chapter on ventriculography is quite fully presented. The author adopts the classification of brain tumors most generally followed to-day—that is, one based on embryology. The remaining part of the work is devoted to a clinical and anatomo-pathologic study of the forty-six cases of brain tumors which the author had seen in his own service during the last ten years. Thirty-six of the cases were primary tumors of the glioma group, and the rest were either metastatic cancers principally, or tuberculomas of the cerebrum and cerebellum. The text is illustrated with 169 cuts, chiefly microscopic sections of the author's personal cases. Curiously enough, there were as many male as female patients. The author finds a wide variation in the symptomatology of brain tumors, and foresees a remaking of our conceptions of the physiology of the brain and of the nerve centers, not only with respect to the better-known brain areas, but with respect to its supposedly silent areas.

Unfortunately, most of the author's patients presented such an advanced condition as to preclude successful intervention in all but a small number of them. The failure of the interventions has more than convinced the author as to the great need of early diagnosis and of operating at the opportune time; that is, during l'heure chirugicale.

It would have added to the value of the monograph if the author had discussed each case as presented; also it would have facilitated identification if the illustrations were cited parenthetically in the text or labeled with the respective case numbers.

In the preface Dr. Clovis Vincent emphasizes the fact that in the diagnosis of brain tumors it is not so much a question of great knowledge of neurology as of method in examination that counts; further, that it does no good to wait long for the result of therapeutic tests in suspected cerebral gummas since these are rare; less than 2 per cent by American statistics and less than 1 per cent by French statistics.—C. R.

Infections of the Urinary Tract. By T. E. Hammond. H. K. Lewis & Co., Ltd., London, 1935. 250 pp. Price, $2.25.

This monograph, many of whose chapters have already appeared in the Clinical Journal and in the Lancet, treats only of gonorrhœa, coli infections, and staphylococcal diseases of the genito-urinary tract, but is otherwise well presented and bal-

anced. In the chapter on frequency of micturition, one is told that women pass urine less often than men, not because their bladders are larger, but because, owing to the absence of facilities, they accustom themselves to retention for long periods. In the chapter on the diagnosis of bacterial disease of the urinary tract is given much sound, common-sense advice as to how properly to secure urine specimens for examination, a simple enough thing, it would seem, but rarely attended to scrupulously. One learns with interest that in the author's practice 80 per cent of urinary infections in both sexes are due to *Bacillus coli*. Quoting Harrison, the author says that once catheterization was started for the enlarged prostrate the average duration of life was four years, death taking place from infection of the kidneys. He speaks of "marriage-bed" pyelitis, although the health of most women improves after marriage. To him it seems that natural immunity to the gonococcus undoubtedly does exist. He believes that at present gonorrhœa is treated more efficiently than before the war, but this is due to diffusion of knowledge rather than to any advance in treatment. One is rather surprised to read that many students qualified without having a case treated or without having heard a lecture. The author lays emphasis on the bearing of the constitution upon gonorrhœa, and upon that of disease upon the course of gonorrhœa. Age, he believes, does produce some variation in the lesion that is produced by the staphylococcus, and he gives illustrations in support of his contention. The chapter on staphylococcal disease is particularly illuminating.

Unusual to a book of this kind are three appendices, one of which is on the bearing of the constitution upon bacterial disease, and the others on the practice of medicine, which make very interesting and illuminating reading, particularly the latter, from the standpoint of present medical education. In the first appendix the author elaborates on the theory of hypersthenic and hyposthenic types of constitution, at the same time giving a summary account of the theories which this thing that passes as constitution or something has undergone at different periods in the history of medicine.—C. R.

Sex Habits, a Vital Factor in Well-Being. By A. Buschke and F. Jacobsohn. Tr. from the German by Eden and Cedar Paul. Emerson Books, Inc., New York, 1933. 204 pp., illus. Price, $2.50.

This is the English translation of the work originally written in German by Drs. Abraham Buschke and Friedrich Jacobsohn.

Doctor Buschke is a specialist in urology and dermatology, and he and his colleague, Doctor Jacobsohn, have distinguished themselves by their writings on sexual hygiene and venereal disease. The present work speaks of the interest both have taken in the importance of healthful sex living.

The book is one of the sanest written on the subject. Sex functions and sex problems are discussed clearly and without bias. By limiting themselves to factual knowledge alone, the authors have succeeded in amassing concise information which meets the needs of parents, ministers, legislators, jurists, social workers, and others who deal with sex problems.

The anatomical and scientific descriptions alone are enough justification for the existence of this book. These with the chapters on puberty and sex impulses will serve as clear guides to parents in handling the many problems they have to face. The discussions on sex abnormalities also will give better understanding of conditions generally vague to the public, including some medical practitioners.—U. D. M.

The American Farmer and the Export Market. By A. A. Dowell and O. B. Jesness. The University of Minnesota Press, Minneapolis, 1934. 269 pp. Price, $2.

By getting down to the facts and presenting them as they are, the authors bring together all the factors affecting the American farmers and the distribution of their products into an interpretative discussion uncolored by speculative theories and open to intelligent consideration. The book covers a range of vital subjects from the present agricultural conditions to the problems of international trade with illustrations and maps scattered here and there calculated to give the reader a more comprehensive grasp of the topics dealth with.

The opening chapters deal with the fundamental characteristics of the present American agricultural resources and the different improvements introduced in the way of increasing the output of the farm. Crop production is analyzed from the standpoint of acreage devoted to crops and in its relation to topography, climate, and other factors that affect agricultural production in different localities. Dairying and animal production are similarly treated. Thus, the reader is furnished with sufficient background for the later chapters that touch on overproduction and distribution. The trends of production, exports, population, and consumption and their interrelations are pointed out. The cityward movement of populations is discussed to

illustrate its bearing on the present agricultural conditions of the United States. With the decline of the per capita consumption of food the question arises: Is underconsumption instead of overproduction, as is now popularly believed, the real core of the problem? The authors attempt to give a broad answer by displaying the outstanding facts from every angle, without, however, pinning too much hope on increased consumption.

After discussing the effects of modern methods of agriculture on labor replacement and surplus production, the authors turn to the possibility of shifting from export to import products with the aim in view of adjusting agriculture to a basis of self-sufficiency. In this connection a suggestion has been advanced to restrict importation of coconut oils, which principally comes from the Philippines, in order to give way to domestic butter production. But then, the authors remark wittingly, to eliminate coconut oil is to eliminate oleomargarine, soap, and other oil products manufactured in the United States. Such elimination, the authors contend, would hardly be in the domestic favor. Limitation of sugar importation from the Philippines was once suggested by some Americans as a method of increasing domestic production of the product. Again, the authors believe, such action would hardly provide additional protection to domestic producers.

The next chapters are concerned with the question of the practicability of self-sufficiency in regard to agricultural production and with the position of the American farmer in the world production of wheat, corn, and cotton and the possibilities attendant thereto. In the course of the discussion of the protection of farm products, attention is turned towards the subject of governmental policies in international trade. Mention is made of the marked interest all countries have shown since the World War in trade policies, balance of trade, and international trade coöperation. The closing chapters cover the most important recent developments in economic nationalism in America, prominent among which are the Agricultural Adjustment Act and the National Recovery Act which have largely been responsible in arousing national consciousness and public opinion anent economic problems, whose manifold questions and complexities remain to be solved.—L. Ma. C.

Vanishing Farm Markets and Our World Trade. By T. W. Schultz. (World affairs pamphlets, No. 11.) World Peace Foundation, Boston and New York, 1935. 41 pp. Price, $0.50.

This book is everything that its title implies and gives a vivid picture of the gradual disappearance of the farm markets as effected by the present world trade of the United States.

The rise of the American tariff makes it difficult to sell foreign goods with a profit in the United States. By thus reducing the purchasing power of other nations, this policy limits their capacity to absorb the United States surplus farm products, which they heretofore demanded. The author believes that if this situation continues grave adjustments are necessary for American agriculture. Neither the correction of its reciprocal tariff nor the operation of the Agricultural Adjustment Act or a similar act, which renders only a temporary improvement of farm products, is sufficient to meet the problem. The author suggests a more liberal foreign-trade policy as the best solution in order to facilitate a more normal cost and price level of agricultural products. The other method is the curtailment of production, but this will involve the shifting from one crop to another, which is quite difficult to achieve. The well-presented charts enhance the usefulness of the book.—F. G. G.

Criteria of Capacity for Independence. By W. H. Ritsher. American University of Beirut Publications of the Faculty of Arts and Sciences, Social Science Series No. 8. Syrian Orphanage Press, Jerusalem, 1934. 152 pp. Price, $2.

This painstaking study deals with the movements for independence in Iraq, the Philippines, and India. It describes the criteria for the independence of the three countries, one of which (Iraq) is already independent, and another (the Philippine Islands) is in its ten-year transition period for complete independence. The fate of British India in its movement for independence is still uncertain.

Professor Ritsher discusses the standards necessary for the recognition of new states or for admission into the League of Nations, with special emphasis upon the criteria of the capacity of Iraq in fulfilling the requirements set forth by the Permanent Mandates Commission in connection with her application for membership in the League.

The author considers as the first essential requirement for independence the maintenance of a stable government supported by (*a*) an administration capable of maintaining the regular operation of essential government services; (*b*) capacity to maintain the territorial integrity and political independence; (*c*) the maintenance of public order and security throughout the whole territory; (*d*) adequate financial resources to provide

regularly for normal government requirements; (*e*) laws and a judicial organization which will afford equal and regular justice to all; and (*f*) a united public opinion supporting the demand for independent status. The existence of a clear intention to fulfill the international responsibilities and obligations, including (*a*) effective protection of minorities; (*b*) protection of the rights and properties of foreigners; (*c*) religious freedom; (*d*) obligations to assume public debts of the former administration; (*e*) the recognition of rights legally acquired under the former administration, is the second fundamental criterion, according to the author, that has met with general approval.

As always happens, there has been a divergence of opinion between the mother country and the territory aspiring for independence. The author explains that this can be removed by the establishment of an objective and quantitative method to determine the amount of accomplishments by the natives in self-government. With the adoption of such a measuring rod, there would not be much quarrel as to the fitness of the subject countries for independence. The author forgets that due to the complex forces surrounding a colonial acquisition, it is utterly impossible to set up fixed criteria of the capacity of a subject people for independence. He admits, nevertheless, that the Indians, the Filipinos, and the Iraquis have the right to base their claims for independence on the principle of self-determination and the inalienable right of peoples to govern themselves and administer their own affairs.—F. M.

Incompatibility in Prescriptions and How to Avoid It. By Thomas Stephenson. 4th ed. rev. and enl. The Prescriber Offices, Edinburgh, 1935. 62 pp. Price, $2.

This is the fourth edition of the work which originally appeared as a series of articles in the Prescriber, collected and first published as a 32-page pamphlet in 1915. It is intended to provide a more or less complete guide to prescribing, by treating the general principles of incompatibility and giving an alphabetical list of drugs with their doses, solubilities, and incompatibilities. The book, therefore, includes valuable facts about the latter which should prove of value in prescription writing. Obviously, however, not only physicians would welcome this book, but pharmacists especially would find it of great assistance in dispensing.—B. M.

INDEX

[New names and new combinations are printed in boldface.]

B

H

M

N

Q

R